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PRELIMINARY ETF ENVIRONMENTAL ANALYSIS AND SITE SUITABILITY STUDY

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Draft Topical Report
October 31, 1977

U.S. DEPARTMENT OF ENERGY
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INTRODUCTION

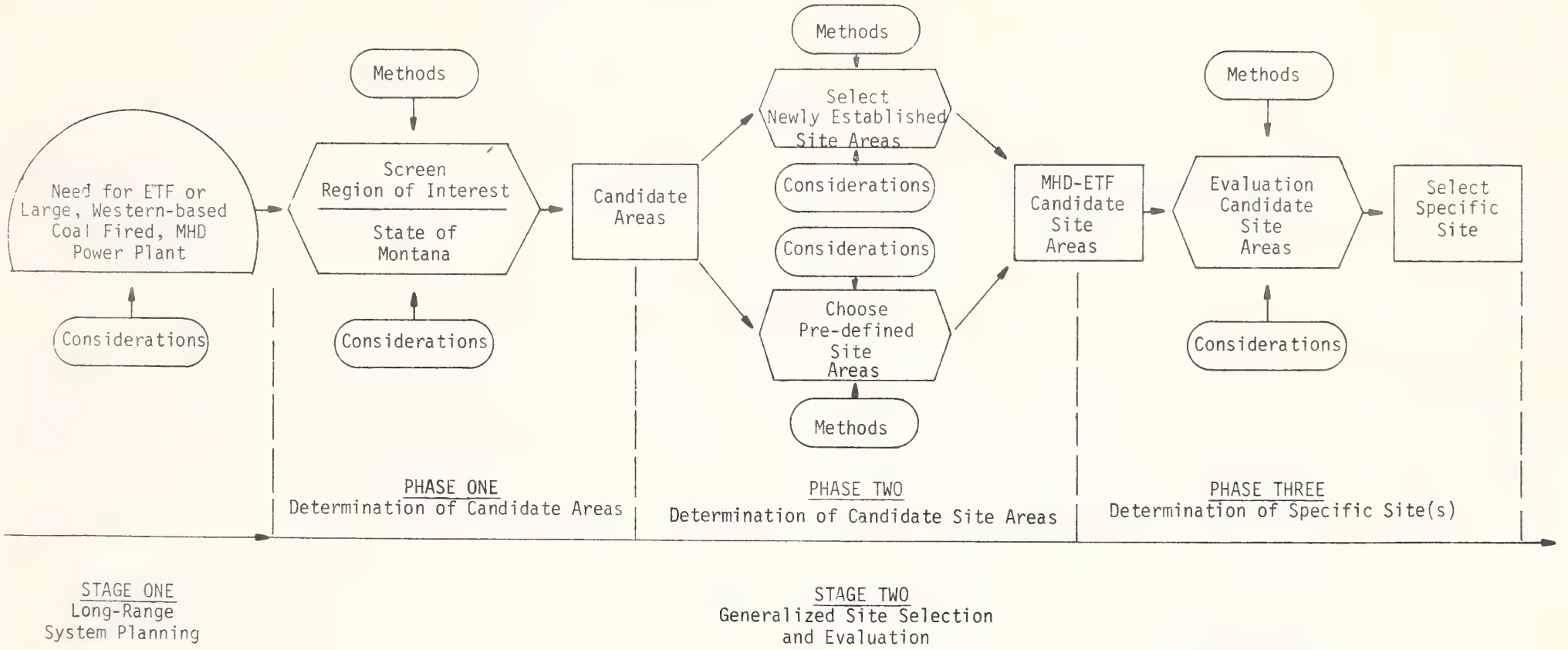
During FY 77, the site selection study was directed at identifying one or more suitable specific sites for an MHD Engineering Test Facility in Montana. As shown in Figure 1, the MHD power plant siting process was divided into three phases. Phase I and Phase II involved the determination of candidate areas and candidate site areas (CSA) within Montana. Based on this analysis, five CSA's emerged as suitable: 1) Billings; 2) Butte-Anaconda; 3) Glasgow Air Force Base; 4) Great Falls; and 5) Livingston-Bozeman.

Phase III analysis is directed at examining the impact considerations as depicted in Figure 2. This report, prepared by MERDI personnel, analyzes existing baseline data for the following phase III considerations:

1. transportation access;
2. utility corridors - electrical transmission systems;
3. air quality;
4. meteorology/noise;
5. groundwater resources (hydrology); and
6. legal aspects of water availability.

Other baseline data, including surface water hydrology, geology, soils, terrestrial vegetation, wildlife and aquatic biology, was gathered by the consulting firm of Sawyer-Waring and Associates and is presented under a separate cover.

Figure 1.--MHD Power Plant Siting Process



SUBSEQUENT STAGES ARE:

Stage Three: Pre-construction licensing of site and plant design

Stage Four: Construction and operation

Figure 2.--Impact Assessment Parameters

NATURAL ENVIRONMENT

Meteorology/Noise	Topography	Geology/Soils	Hydrology	Ecology	Resource Availability
air currents & stability	slope	soil condition	water quantity & availability	wildlife	coal
air quality	land form	seismic activity	water quality	vegetation	oil
air temperature			flood zones	rare & endangered species	oxygen
					nitrogen

HUMAN ENVIRONMENT

MHD program requirements	Utility corridors	Transportation access	Land use	Archaeology	Socio-economic	Social acceptability
existing government sites	electrical grids	highway	ownership	historical sites	employment	cultural characteristics
program continuity	available start-up & output capability	railway	natural areas	archaeology sites	income	historical conditions
		airways	recreational	religious sites	under-utilized labor force	social profile
			wildlife refuge		financial resources & expenditures	
			wilderness & primitive areas		community facilities & services	
			residential		population characteristics	
			commercial			
			irrigated			
			dryland			
			rangeland			
			forest			
			zoning regulations			
			waste disposal			

1.0 TRANSPORTATION FACILITIES AVAILABLE IN FIVE MONTANA CANDIDATE SITE AREAS

1.1 Introduction

This report describes the transportation facilities available in the five Candidate Site Areas (CSA's). The railroad lines, the airlines, the bus lines, and the interstate highway system are the four means of travel addressed.

Generally each of the CSA's is quite accessible, although the Glasgow Air Force Base (GAFB) CSA does not have any present or projected interstate routing and the Great Falls CSA does not have railroad passenger transportation available.

Maps of travel routes are included, along with tables describing the types and frequencies of service in each of the major cities in the CSA's.

1.2 Rail Service

The Montana railroad system consists of 4862 miles of track (not including sidings and parallel tracks) owned by seven railway companies (Delano, 1977).

Three major companies presently operate within the CSA's - Milwaukee Railroad Company, Union Pacific Railroad Company, and Burlington Northern Railway Company. Each organization has stated that their main lines are of sufficient quality to allow transportation of 7-30 unit trainloads of coal per year (Davies, 1977; Height, 1977; Joanasen, 1977). This range is derived from figures presented by General Electric, Westinghouse, and Avco-Everrett in their Draft, "MHD-ETF Program Design Requirements and Criteria" and from scaled-up estimates of projected coal usage for the Component Development and Integration Facility.

Almost all existing spur lines within the state, including the line to GAFB, are rated at 90-pound per yard trackage. To be strong enough to

transport coal and heavy supplies the lines in question would have to be upgraded to 130 pound trackage. This process costs roughly $30 per track-foot if new track and additional ties must be added to the rail bed, and it costs about $40 per track foot if ballast (rip-rap of stream beds and gravel added to the rail bed) must be supplied also (Delano, 1977).

High construction costs and the probability of environmental disputes have been major reasons for little new track being laid within the state in recent years. These costs may range from $500,000 to $1,000,000 per mile depending on the type of terrain encountered, the number of bridges required, etc. A small bridge (50 to 60 feet long) may cost $1,000 to $2,000 per foot to build, and these construction costs escalate rapidly as distance to be spanned increases (Delano, 1977).

Amtrak, the National Railroad Passenger Corporation, doesn't own any lines within Montana; however, it maintains passenger service by renting Burlington Northern tracks. Historically only east-west transportation is available along a northern route through Havre and along a southern route through Billings (Figure 1-1). On September 15th of each year, Amtrak changes its schedule from daily to three-day-a-week service on the southern route and to four-day-a-week service on its northern route (Amtrak, 1977).

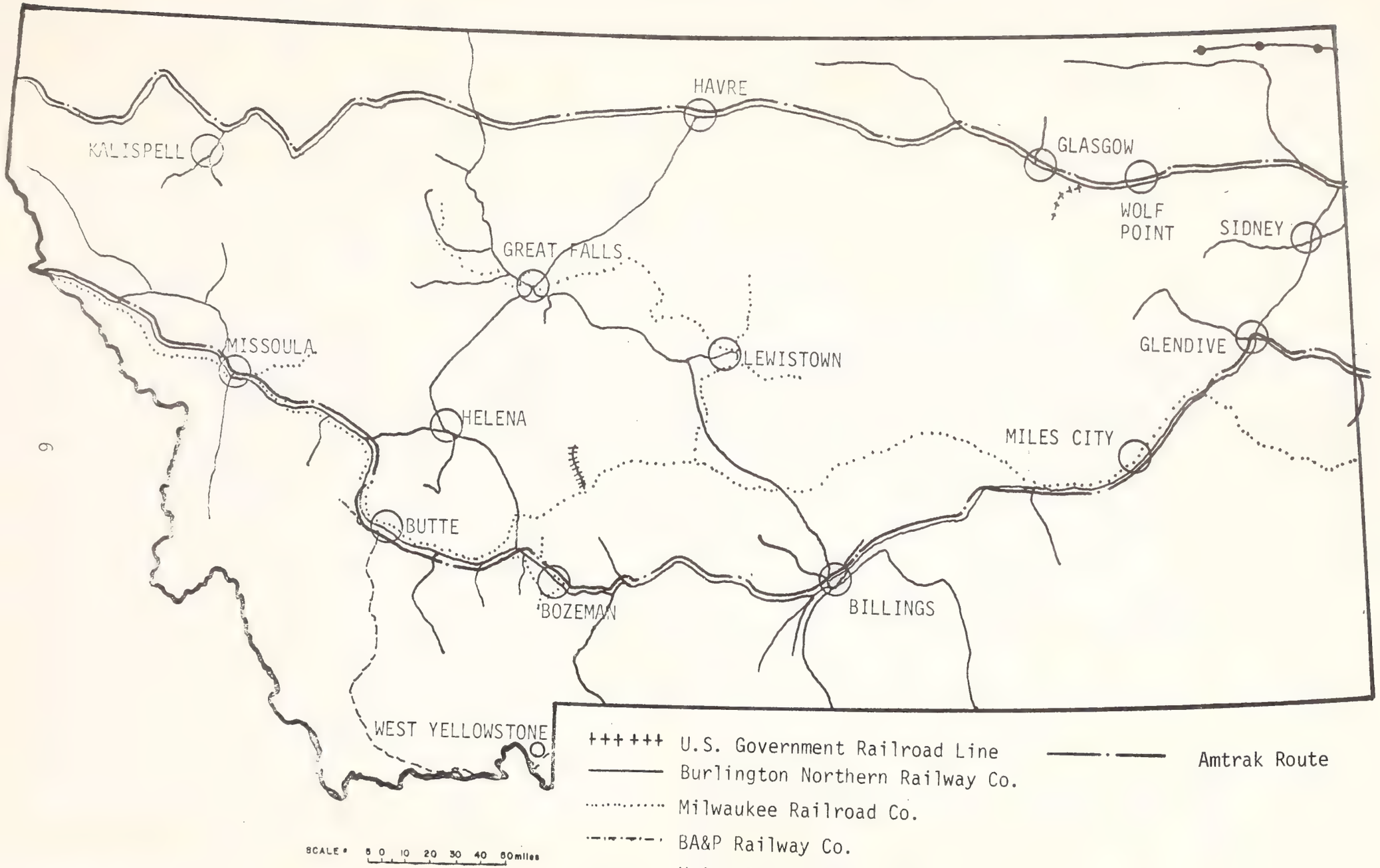
Table 1-1 lists the rail facilities available in each CSA.

1.3 Airlines

Montana is served by four major commercial airline companies: Northwest Orient Airlines, Western Airlines, Frontier Airlines, and Hughes Air West. Each airline offers passenger service as well as cargo service in the form of air express and package transportation. The routes flown by these companies (both within the state and outside the state) are displayed in Figure 1-2 (Frontier, 1977; Western, 1977; Northwest, 1977; Hughes, 1977).

As shown in Tables 1-2 through 1-6, Logan Field International Airport,

Figure 1-1.--Montana's Railroads (1977)



Source: Great Northern Railway Company, 1967
Amtrak, October 31, 1976

Table 1-1.--Railroad Facilities

Company	Service	Nearest Destination	Number of Trains/Week[1]
BUTTE			
Amtrak	passenger and freight	Bozeman	3
		Missoula	3
Burlington-Northern	freight	Great Falls	7
		Bozeman	10
		Missoula	14
Union-Pacific	freight	Dillon (south)	7
		Missoula	21
Milwaukee	freight	White Sulphur Springs (northeast)	21
B. A. & P.	freight	Rocker (west)	7
ANACONDA			
B. A. & P.	freight	Rocker (east)	7
BOZEMAN			
Amtrak	passenger and freight	Livingston (east)	3
		Butte	3
Burlington-Northern	freight	Livingston (east)	28
		Butte	24
		Townsend (north)	7
Milwaukee	freight	Butte	call basis only
LIVINGSTON			
Amtrak	passenger and freight	Bozeman	3
		Billings	3
Burlington-Northern	freight	Bozeman	24
		Billings	28
		Yellowstone Park	call basis only

Source: Local railroad company offices, 1977.

Table 1-1.--Railroad Facilities (continued)

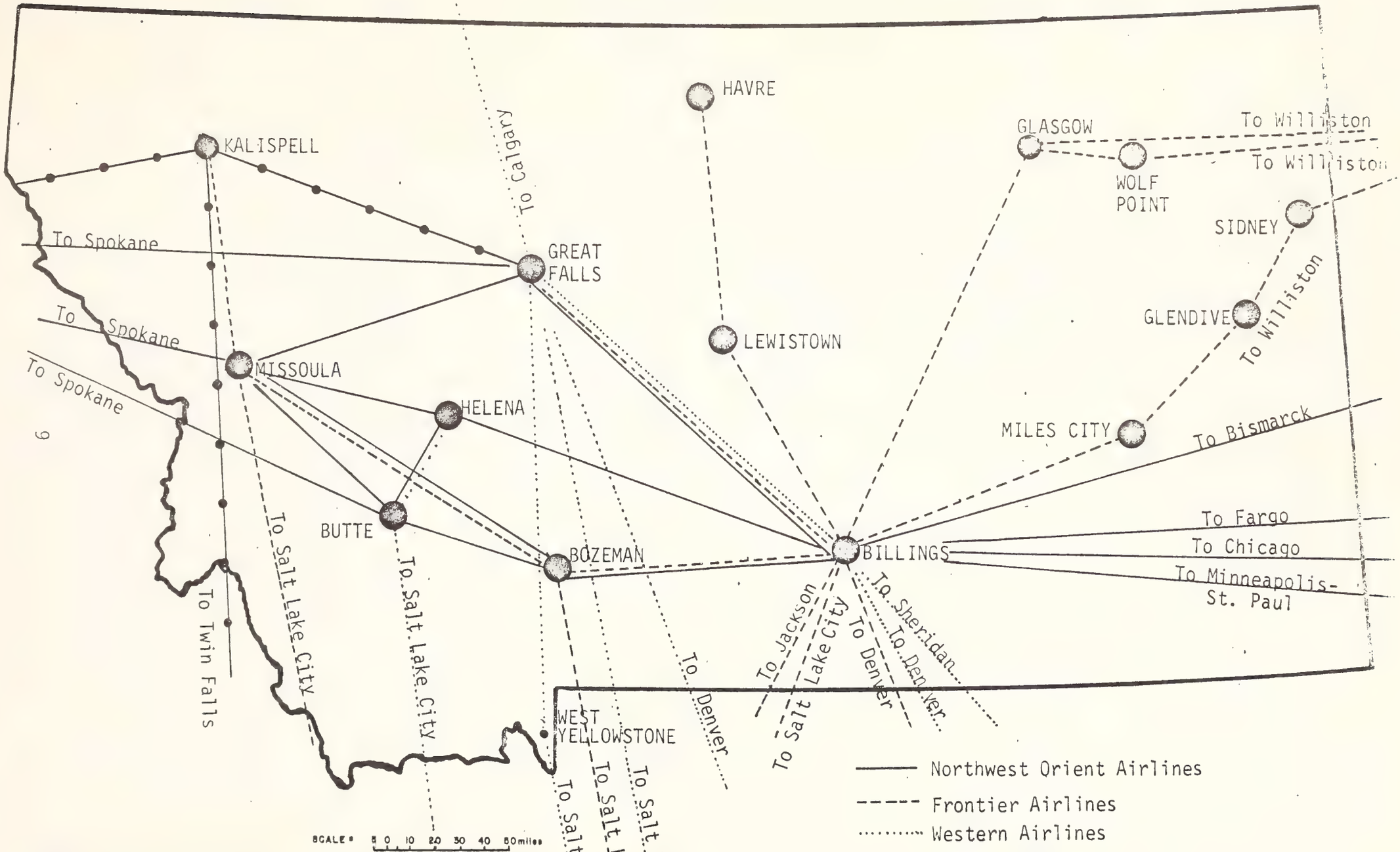
Company	Service	Nearest Destination	Number of Trains/week[1]
BILLINGS			
Amtrak	passenger and freight	Livingston (west)	3
		Miles City	3
Burlington-Northern	freight	Livingston	28
		Miles City	28
		Great Falls	7
		Hardin (southeast)	14
		Laramie (southwest)	14
GREAT FALLS			
Burlington-Northern	freight	Helena	7
		Billings	4
		Havre	7
		Shelby (north)	7
Milwaukee	freight	Lewistown	7
		Agowom (northwest)	14[2]
GLASGOW			
Amtrak	passenger and freight	Havre	3
		Wolf Point	3
Burlington-Northern	freight	Havre	42
		Wolf Point	42

[1] These schedules are average figures subject to change upon demand.

[2] Wheat season only

Source: Local railroad company offices, 1977.

Figure 1-2.-- Montana's Airline Routes (Spring 1977)



Source: Frontier Airlines, April 24, 1977
Western Airlines, July 1, 1977
Northwest Orient Airlines, Inc., June 8, 1977
Hughes Air West, July 1977

Table 1-2.--Air Transportation Facilities in Billings CSA

Major Airlines Serving Community	Nearest Destination	Number of Flights per day	Nearest Commercial Airport	Distance from Billings
Western	Denver, CO	3		
	Great Falls, MT	1		
	Sheridan, WY	1		
Northwest Orient	Bismark, ND	2	Logan Field International	2 miles
	Bozeman, MT	2		
	Chicago, IL	2		
	Fargo, ND	1		
	Great Falls, MT	3		
	Helena, MT	3		
	Minneapolis, MN	1		
Frontier	Bozeman, MT	1		
	Denver, CO	3		
	Glasgow, MT	2		
	Great Falls, MT	2		
	Jackson Hole, WY	1		
	Lewistown, MT	1		
	Miles City, MT	1		
	Salt Lake City, UT	2		

Private Airports in CSA	Public Airports in CSA	Military Airports in CSA
Shaules	Logan Field International	
	Laurel Airport	

Source: Western Airlines, July 1, 1977
Northwest Orient Airlines, Inc., June 8, 1977
Frontier Airlines, April 24, 1977
Montana Aeronautics Division, January 6, 1976

Table 1-3.--Air Transportation Facilities in Livingston-Bozeman CSA

Major Airlines Serving Community	Nearest Destination	Number of Flights per day	Nearest Commercial Airport	Distance from Livingston
	Billings, MT	3		
	Butte, MT	1		
Northwest Orient	Missoula, MT	1		
	Billings, MT	1		
	Missoula, MT	2	Gallatin	
Frontier	Salt Lake City, UT	1	Field	35 miles

Private Airports in CSA	Public Airports in CSA	Military Airports in CSA
Ecton	Gallatin Field	
Cadwell	Mission Field	
	Three Forks	
	Big Timber	

Source: Northwest Orient Airlines, Inc., June 8, 1977
Frontier Airlines, April 24, 1977
Montana Aeronautics Division, January 6, 1977

Table 1-4.--Air Transportation Facilities in Butte-Anaconda CSA

Major Airlines Serving Community	Nearest Destination	Number of Flights per day	Nearest Commercial Airport	Distance from Butte
	Helena, MT	2		
Western	Salt Lake City, UT	1		
	Bozeman, MT	2		
	Helena, MT	1	Bert Mooney/	
Northwest Orient	Spokane, WA	2	Silver Bow County	4 miles

Private Airports in CSA	Public Airports in CSA	Military Airports in CSA
Kesler	Bert Mooney/Silver Bow County	
	Anaconda	
	Deer Lodge	
	Boulder	
	Phillipsburg	

Source: Western Airlines, July 1, 1977
Northwest Orient Airlines, Inc., June 8, 1977
Montana Aeronautics Division, January 6, 1976

Table 1-5.--Air Transportation Facilities in Glasgow Air Force Base CSA

Major Airlines Serving Community	Direction of Service	Number of Flights per day	Nearest Commercial Airport	Distance from Glasgow AFB
Frontier	Billings, MT	2		
	Williston, ND	1	Glasgow International	15 miles

Private Airports in CSA	Public Airports in CSA	Military Airports in CSA
Olfert	Glasgow International	Glasgow AFB
Unger	Dick	
Floyd	Hinsdale	

Source: Frontier Airlines, April 24, 1977
Montana Aeronautics Division, January 6, 1976

Table 1-6.--Air Transportation Facilities in the Great Falls CSA

Major Airlines Serving Community	Nearest Destination	Number of Flights per day	Nearest Commercial Airport	Distance from Great Falls
Western	Billings, MT	1	Great Falls International	4 miles
	Calgary, Alberta	2		
	Denver, CO	1		
	Salt Lake City, UT	2		
	West Yellowstone, MT	1		
Northwest Orient	Billings, MT	4		
	Missoula, MT	1		
	Spokane, WA	2		
Frontier	Billings, MT	2		
Hughes Air West	Kalispell, MT	1		

Private Airports in CSA	Public Airports in CSA	Military Airports in CSA
Stephens	Great Falls International	Malmstrom AFB
Barrett	Fairfield	
Burgmaier	Dutton	
Robinson	Carter	
Visocan		

Source: Western Airlines, July 1, 1977
Northwest Orient Airlines, Inc., June 8, 1977
Frontier Airlines, April 24, 1977
Hughes Air West, July 1977
Montana Aeronautics Division, January 6, 1976

2 miles north of Billings, accommodates more flights per day than any other airport in the state; this is almost twice as many as Great Falls International Airport, the next most busy airport (Frontier, 1977; Western, 1977; Northwest, 1977; and Hughes, 1977).

The Bert Mooney/Silver Bow County Airport, 4 miles south of Butte, handles the commercial air traffic for the entire Butte-Anaconda CSA. The Anaconda field is not large enough to accommodate major commercial planes; therefore, it caters primarily to small private aircraft.

Similar circumstances are found in the Livingston-Bozeman CSA with Gallatin Field at Belgrade, Montana accommodating the major commercial flights, while Mission Field, 16 miles east of Livingston, is utilized by smaller planes.

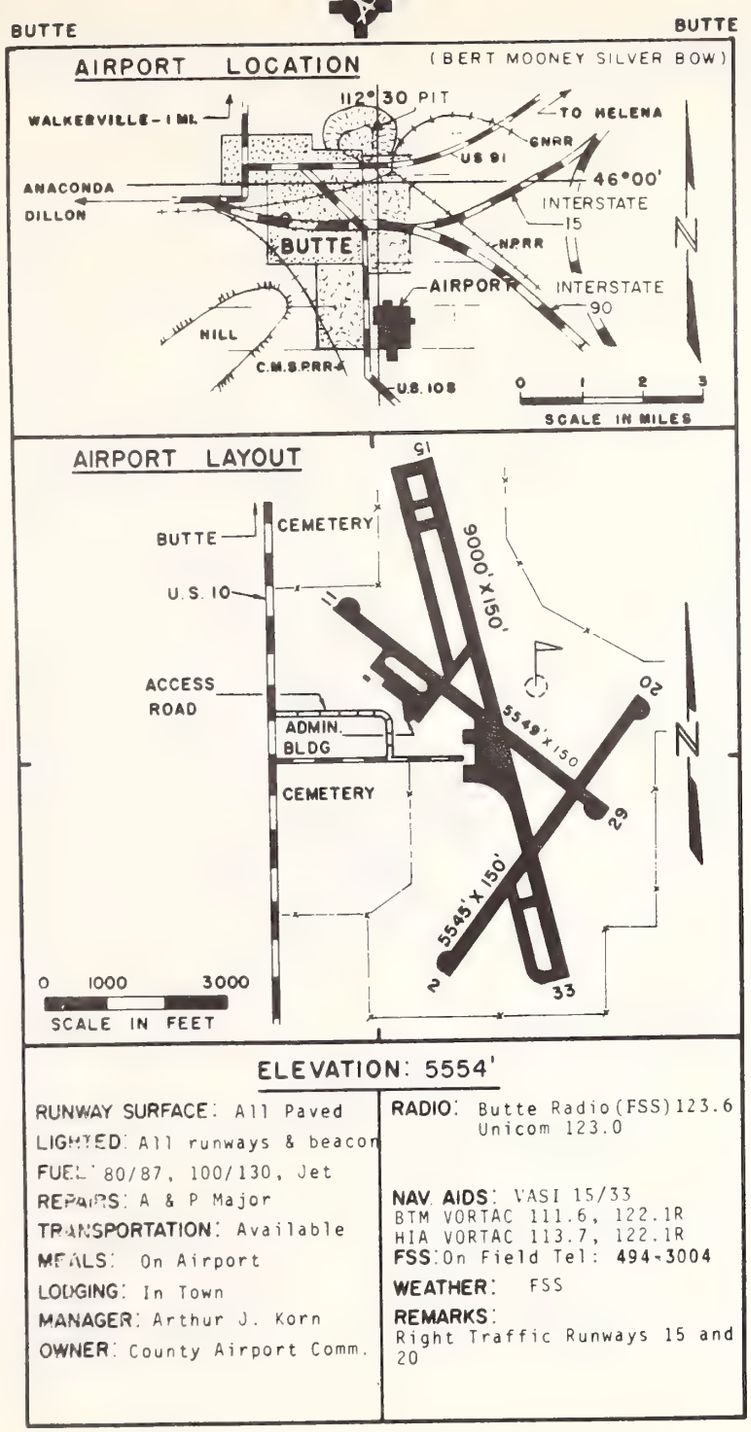
Glasgow Air Force Base (GAFB) Airport, formerly AVCO Glasgow Community Airport, is not maintained for commercial or military traffic; however, civil aircraft may utilize the field during daylight hours, and prearranged night landings are possible. Commercial service within the GAFB CSA is conducted through Glasgow International Airport, 15 miles south of the air base and 2 miles north of the town of Glasgow.

Information on the layouts and locations of the major airports in the five CSA's is displayed in Figures 1-3 through 1-7.

1.4 Bus Lines

With the exception of the Red River Valley Stage, the nine bus companies shown in Figure 1-8 serve most of Montana with intercity passenger, package, and charter service. The Red River Valley Stage, like the Yellowstone Park Lines, operates only during the summer months; however, the former does not have charter service available (local bus company offices, 1977).

Additional facilities within the five CSA's include passenger bus lines



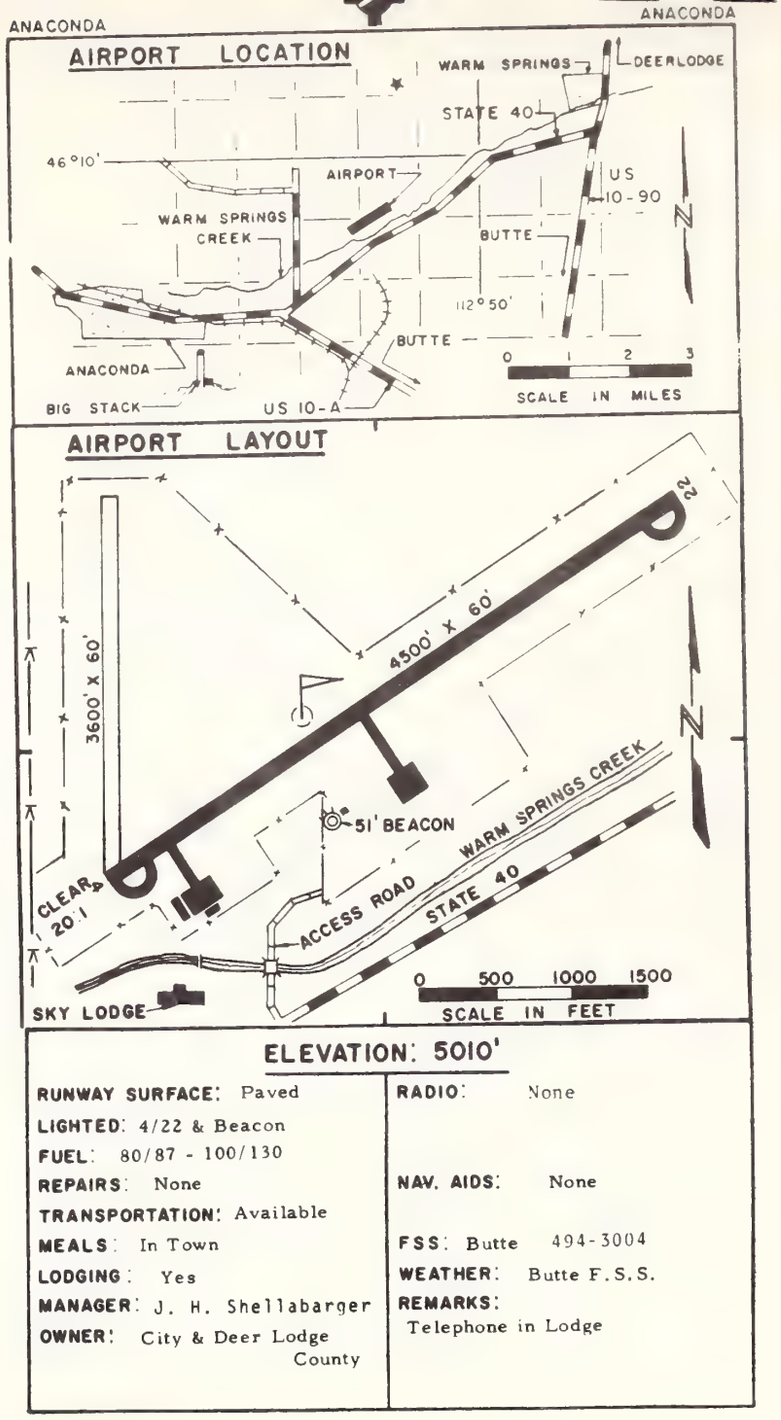


Figure 1-3.--Major Airports in Butte-Anaconda CSA

Source: Montana Aeronautics Division, 1976

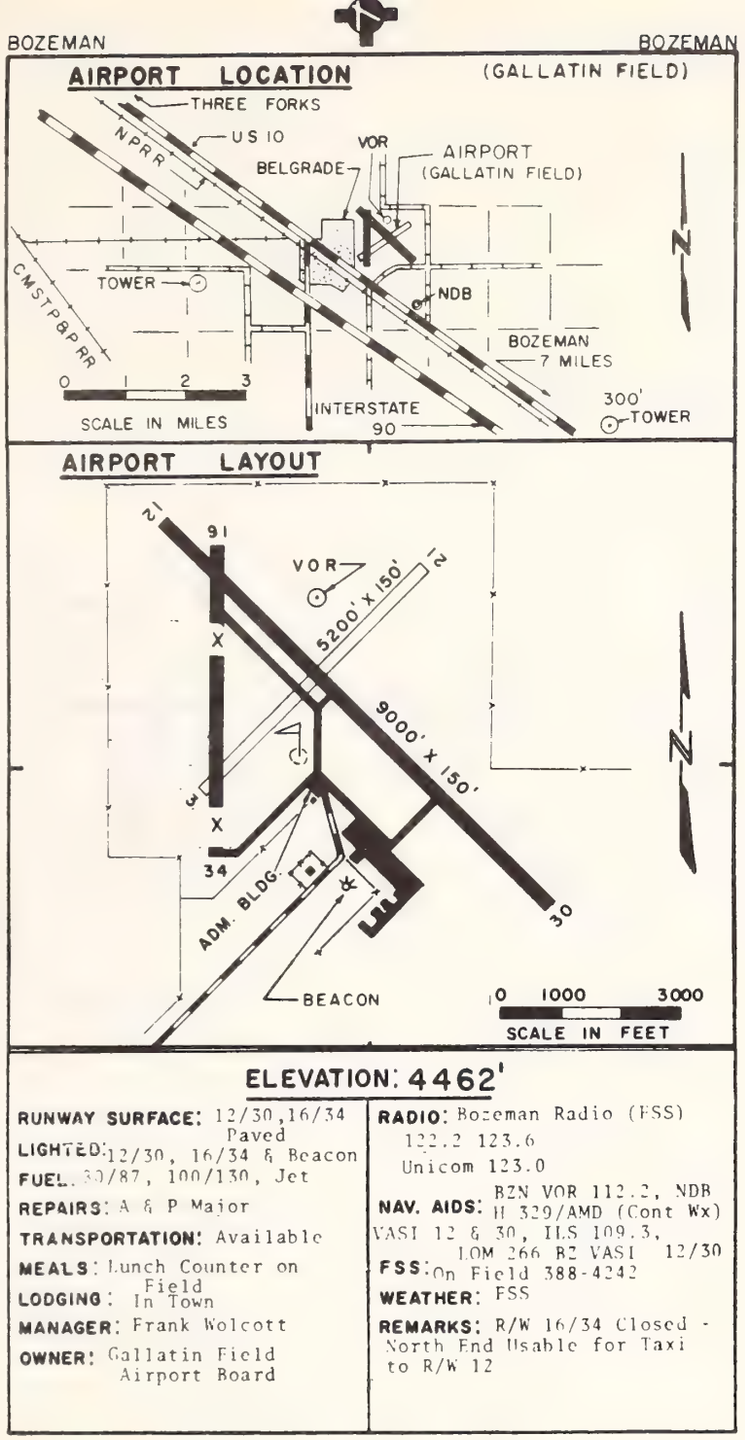
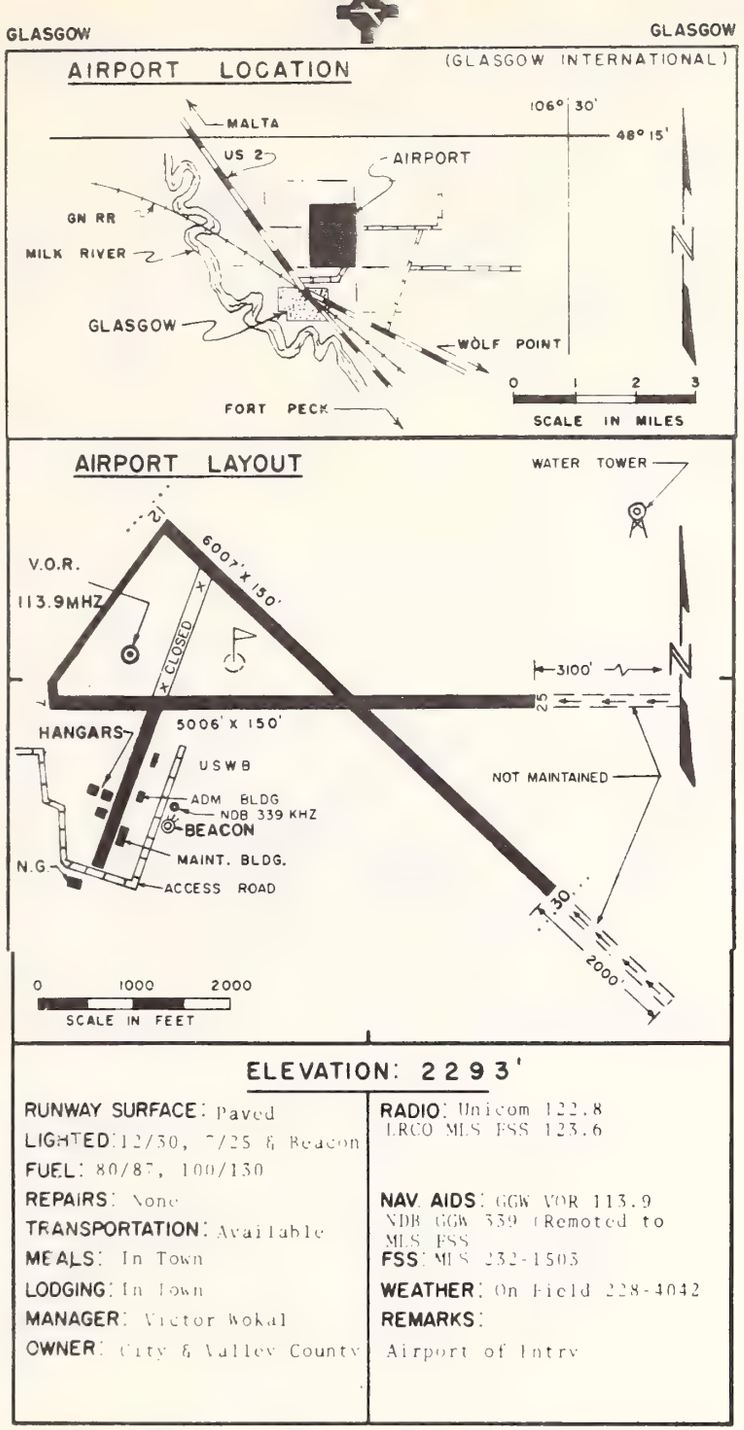


Figure 1-4.--Major Airports in Livingston-Bozeman CSA

Source: Montana Aeronautics Division, 1976



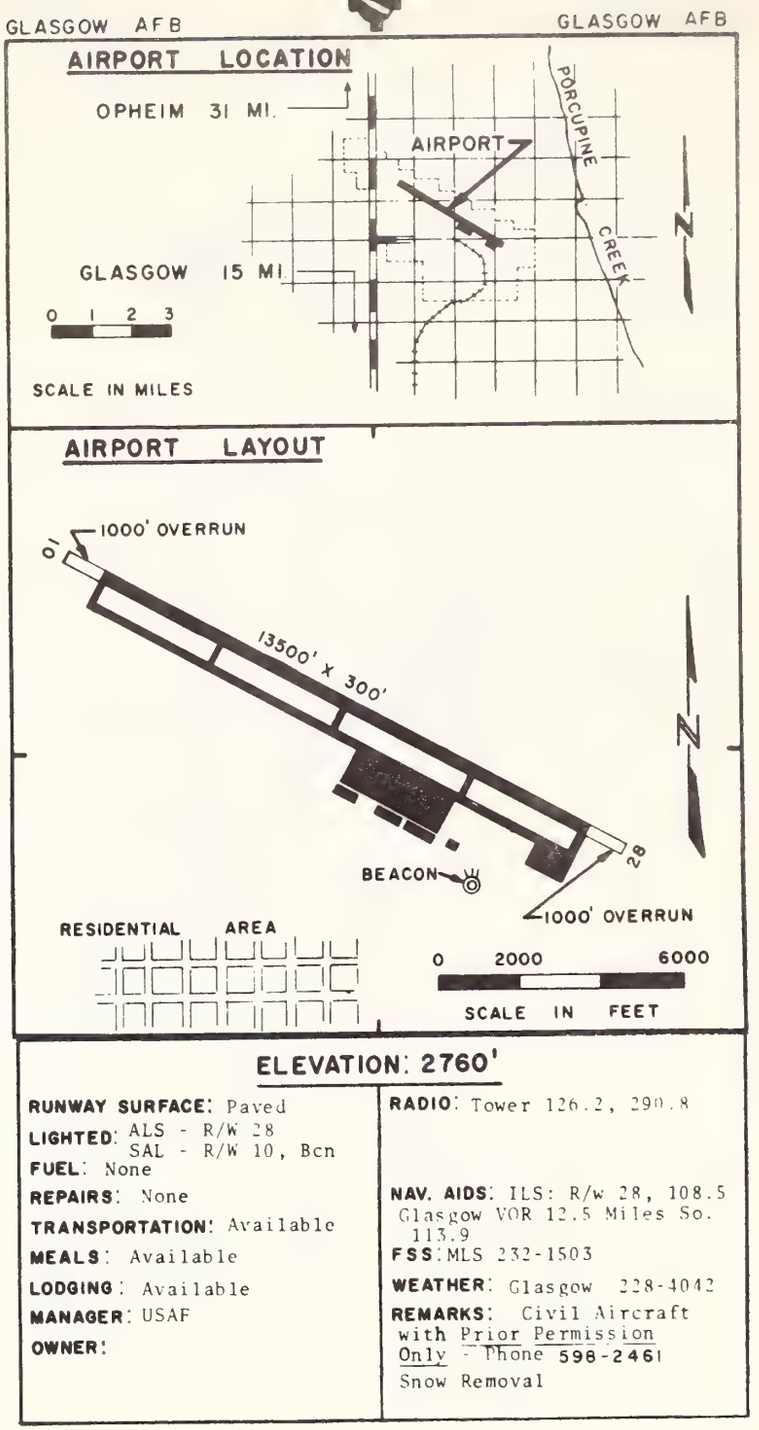


Figure 1-5.--Major Airports in Glasgow Air Force Base CSA

Source: Montana Aeronautics Division, 1976

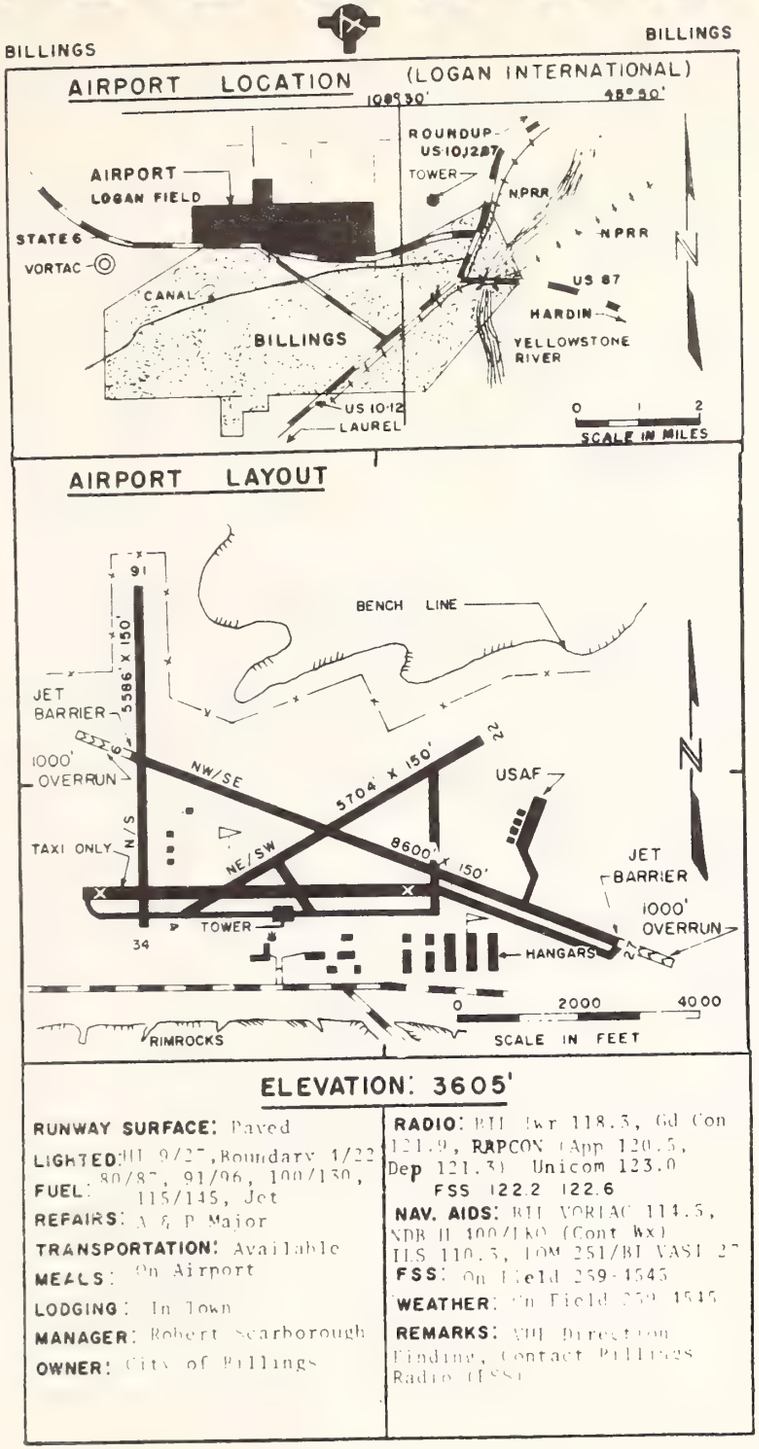


Figure 1-6.--Logan International Airport

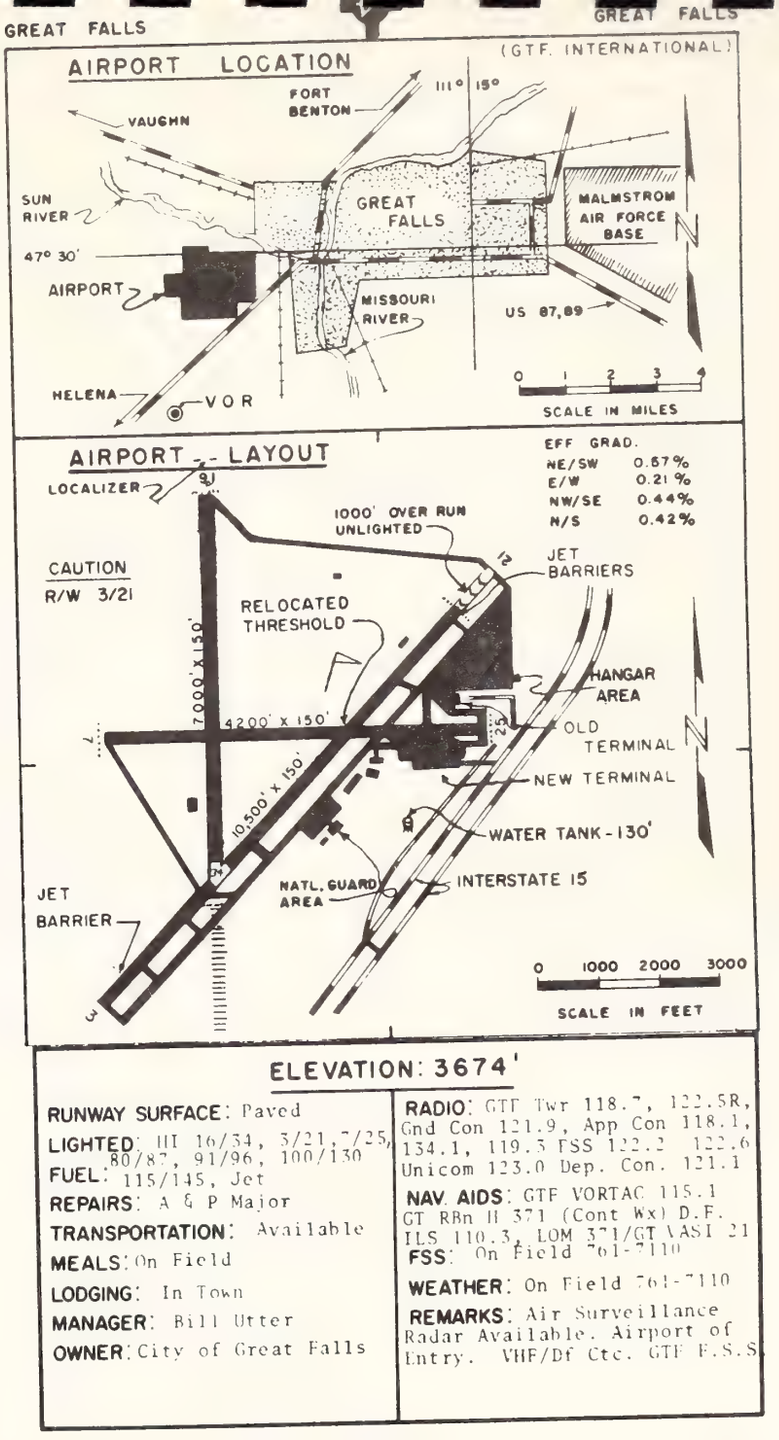
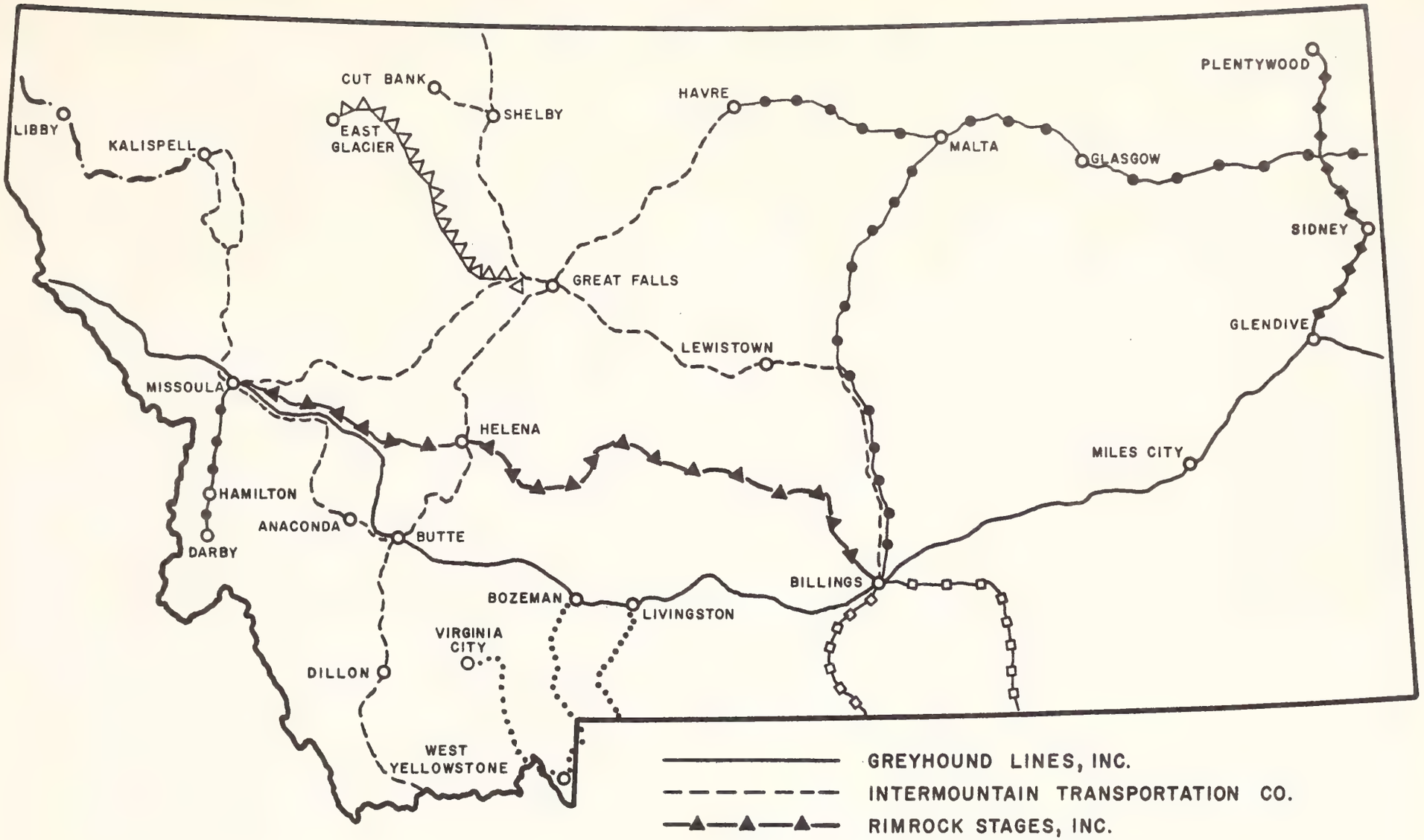


Figure 1-7.--Great Falls International Airport

Source: Montana Aeronautics Division, 1976



SCALE: 1" = (APPROX.) 60 MILES

Source: Russell's Guides, Inc., June 1977.

FIGURE 1-8

MAJOR MONTANA BUS ROUTES

DRAWN BY JIM FERRLAN 8/2/77

within the cities of Billings and Butte and the local school bus systems which serve each of the areas.

Table 1-7 gives a breakdown of the intercity bus companies serving the major cities within the CSA's (Russell's Guides, Inc., 1977).

1.5 Highways

The state of Montana has a well-established primary and secondary highway system connecting all cities and virtually all towns within the state. Also, as of January 1, 1977, 843 miles (71 percent of a planned total of 1187 miles) of multi-lane interstate had been completed (Opitz, 1977).

Figures 1-9 and 1-10 show the planned interstate routing and the sections which already have been constructed. It should be noted that no interstate highway has been constructed or scheduled in the vicinity of the GAFB.

With regard to the scheduled date for completion of the entire Montana interstate system, Mr. H. J. Anderson, Director of Highways, wrote the following:

> "The completion date for the Interstate System was extended to 1990 by the Federal Aid Highway Act of 1976. Prior to this act the completion date for the Interstate System had been 1979 and Montana's Interstate schedule had been set up based on this completion schedule. Numerous changes have been made in our Interstate schedule since this 1990 completion date was made law and there may have to be numerous changes in our Interstate schedule in the future if additional federal funding is not made available to Montana over and above what is set up under the Federal Aid Highway Act of 1976" (Montana State Department of Highways, 1977).

Highway routes between Butte and Great Falls and between Butte and Billings are of particular interest because of the need for information transfer between the Engineering Test Facility and the Component Development and Integration Facility located in Butte. All incomplete sections of interstate along these routes tentatively should be constructed by 1981 (Anderson, 1977).

Table 1-7.--Intercity Bus Service

Company	Buses/day	Nearest Destination
BUTTE		
Greyhound Lines, Inc.	4	Bozeman
	4	Missoula
Intermountain Transportation Co.	3	Helena
	3	Dillon (south)
	6	Anaconda
LIVINGSTON		
Greyhound Lines, Inc.	4	Billings
	4	Bozeman
Yellowstone Park Lines	1	Yellowstone Park
BILLINGS		
Greyhound Lines, Inc.	4	Miles City
	4	Livingston (west)
Intermountain Transportation Co.	2	Great Falls
Rimrock Stages, Inc.	2	Helena
Continental Trailways	2	Hardin (east)
	2	Bridger (south)
Missouri Valley Trails, Inc.	1	Glasgow
GLASGOW		
Missouri Valley Trails, Inc.	1	Malta
	1	Wolf Point (east)
GREAT FALLS		
Intermountain Transportation Co.	2	Billings
	1	Missoula
	3	Helena
	2	Havre
	2	Shelby
Red River Valley Stage	2	East Glacier

Source: Russel's Guides, Inc., June 1977.

Table 1-7.--Intercity Bus Service (continued)

ANACONDA

Company	Buses/day	Nearest Destination
Intermountain Transportation Co.	6	Butte
	2	Missoula

BOZEMAN

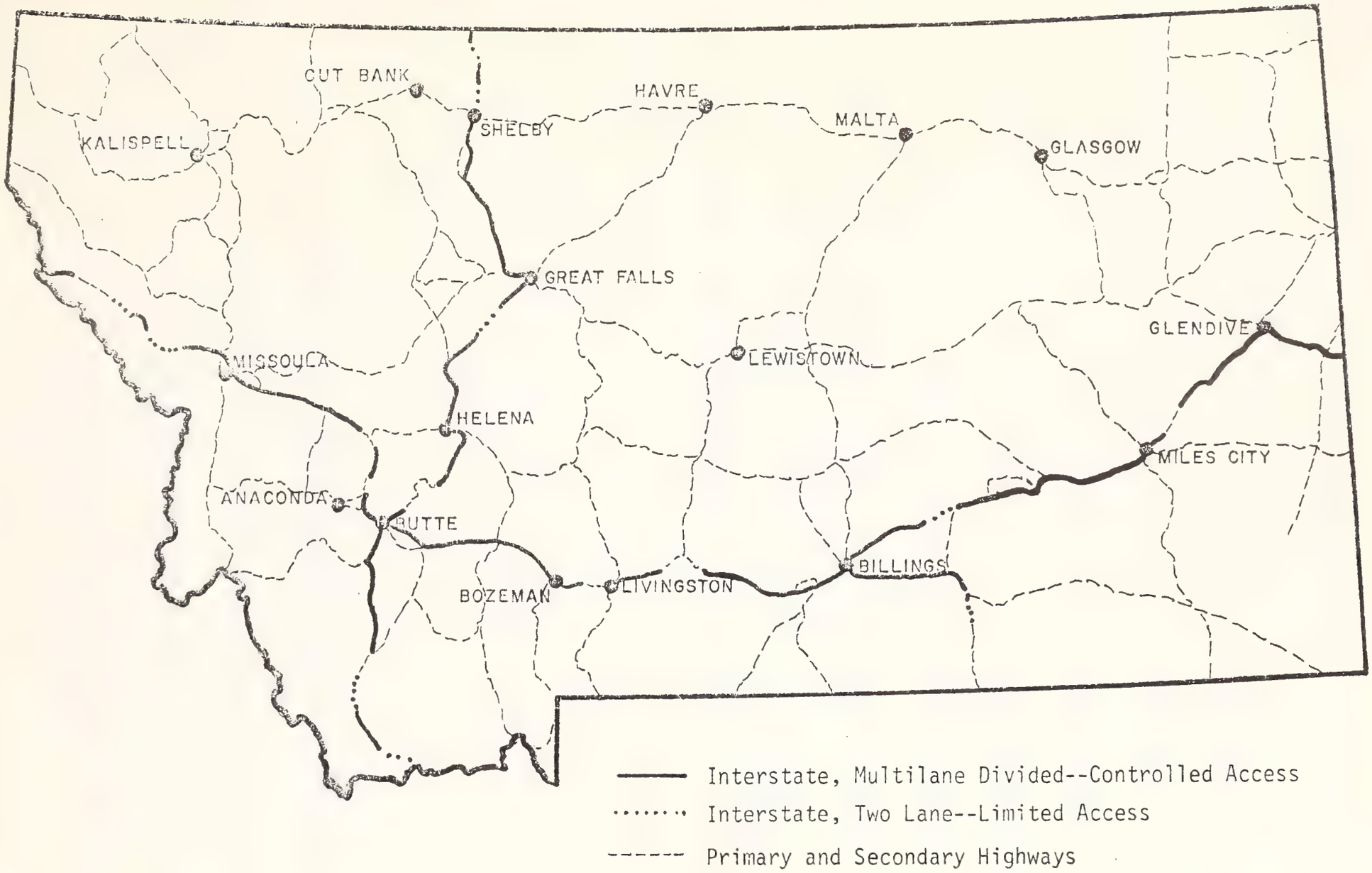
Greyhound Lines, Inc.	4	Livingston
	4	Butte
Yellowstone Park Lines	1	Yellowstone Park

Source: Russel's Guides, Inc., June 1977.

Figure 1-9.--Montana's Planned Interstate Routing

Source: Montana State Department of Highways, April 1, 1977

Figure 1-10.--Montana's Existing Highway System (June 1978)



Source: Keck, September 28, 1977

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2.0 ELECTRICAL TRANSMISSION SYSTEMS IN FIVE CANDIDATE SITE AREAS AND THEIR SUITABILITY TO SERVE THE ENGINEERING TEST FACILITY

2.1 Introduction

An electrical transmission system which can furnish sufficient input power and which can accept an established output load, is essential to an electricity generation facility.

This report describes the estimated input power requirements for the Engineering Test Facility (ETF) and the transmission systems presently available in each candidate site area (CSA) which may be able to supply this energy. Input power is broken down into construction power, start-up power, and auxiliary power.

Also, the utilities which can accept the estimated ETF output are identified for each CSA. Within the Glasgow Air Force Base (GAFB) CSA, a present lack of adequate transmission facilities is noted along with hypothetical plans to construct new lines in this vicinity.

The companies which are being considered for serving the electrical needs of the ETF are the Montana Power Company (MPC), the U.S. Bureau of Reclamation (USBR), the Bonneville Power Administration (BPA), the Pacific Power and Light Company (PPL), and various rural electric cooperatives (REA's).

2.2 Criteria

The following list describes estimates of the electrical characteristics for the ETF based on the draft preliminary design criteria reports prepared for ERDA:

A. Power level $\simeq$ 250 MW_t;

B. MHD power out $\simeq$ 33 MW_e;

C. Steam power out $\simeq$ 95 MW_e;

D. Start-up and auxiliary input power requirement $\simeq$ 15-20 MW_e;

E. Start-up duration $\simeq$ 28 hours;

F. Start-up energy requirements ≃ 24 hours @ half load followed by ≃ 4 hours @ full load;

G. Construction input

1. power requirement ≃ 450-700 KW @ peak demand

2. energy requirement ≃ 150,000-250,000 KWh/month; and

H. Generating time ≃ 2000 hrs./yr. @ 1-100 hour duration intervals.

(Westinghouse, 1977; General Electric, 1977; AVCO-Everett, 1977; Kramarsic, 1977; Wetzel, 1977; Blatnik, 1977; Wilkens, 1977).

During this phase of the ETF Site Suitability Study, 1983 was assumed as the earliest date that power output would be generated. Reconfirmation of available service will have to be made as the ETF construction schedule is altered.

2.3 Construction Input Power

Scaled-down usage figures for three existing coal-fired, electricity generating plants - Commanche 1, Public Service of Colorado; Emery County 1, Utah Power and Light; and Colstrip 2, Montana Power Company - were averaged to produce estimated values for peak construction power demand and monthly construction energy consumption. These values will vary, and are highly dependent on the number of construction workers, the construction time schedule, the plant design, and many other factors particular to ETF construction (Wetzel, 1977; Blatnik, 1977; Wilkens, 1977).

The construction input power conceivably could be furnished by any of the rural electrical cooperatives serving the CSA's; however, only Vigilante Electric Cooperative, Incorporated, located in the southwestern portion of the Butte-Anaconda CSA, has responded affirmatively at this time. Table 2-1 lists the utilities serving each CSA and their capacity to serve the needs of the ETF.

Table 2-1.--Electrical Services Available in Candidate Site Areas, 1977

Utility	Service Capability	Line Sizes (KV)
Butte-Anaconda CSA		
Vigilante Electric	construction power	69
Montana Power Co.	All[1]	50, 69, 100, 161, 230
Bonneville Power Administration	All	230
Livingston-Bozeman CSA		
Park Electric	construction power	69
Montana Power Co.	All	50, 69, 161
Billings CSA		
Beartooth Electric	construction power	69
Yellowstone Valley Electric	construction power	69
Montana Power Co.	All	50, 69, 100, 161, 230
Pacific Power and Light	All	161
Glasgow CSA		
Valley Electric	construction power	69
Northern Electric	construction power	
Montana Power Co.	construction power	69
U.S. Bureau of Reclamation	start-up power	115, 161, 230
Great Falls CSA		
Sun River Electric	construction power	69
Fergus Electric	construction power	
Montana Power Co.	All	50, 69, 100, 115, 161, 230
U.S. Bureau of Reclamation	start-up & output power	161

*1 - includes construction, start-up, and auxiliary input power and output power transmission facilities.

Source: Wilkerson, 1977; Lisbakken, 1977; Anderson, 1977; Bressler, 1977; and Braun, 1977.

The U.S. Bureau of Reclamation (USBR) is the only utility which has stated that it definitely cannot furnish this input. In the Upper Missouri Region, it has marketed all of its firm hydrocapacity and, therefore, cannot make additional commitments for firm power sales (Bressler, 1977).

2.4 Start-up and Auxiliary Input Power

In each CSA, transmission line capacity should be available to supply the start-up and auxiliary power requirements of the ETF. Lines rated at 69 to 100 KV presently are routed throughout the areas, and local utilities have indicated that overloading should not occur in attempting to distribute 15 to 20 MW by this means (see Figure 2-1).

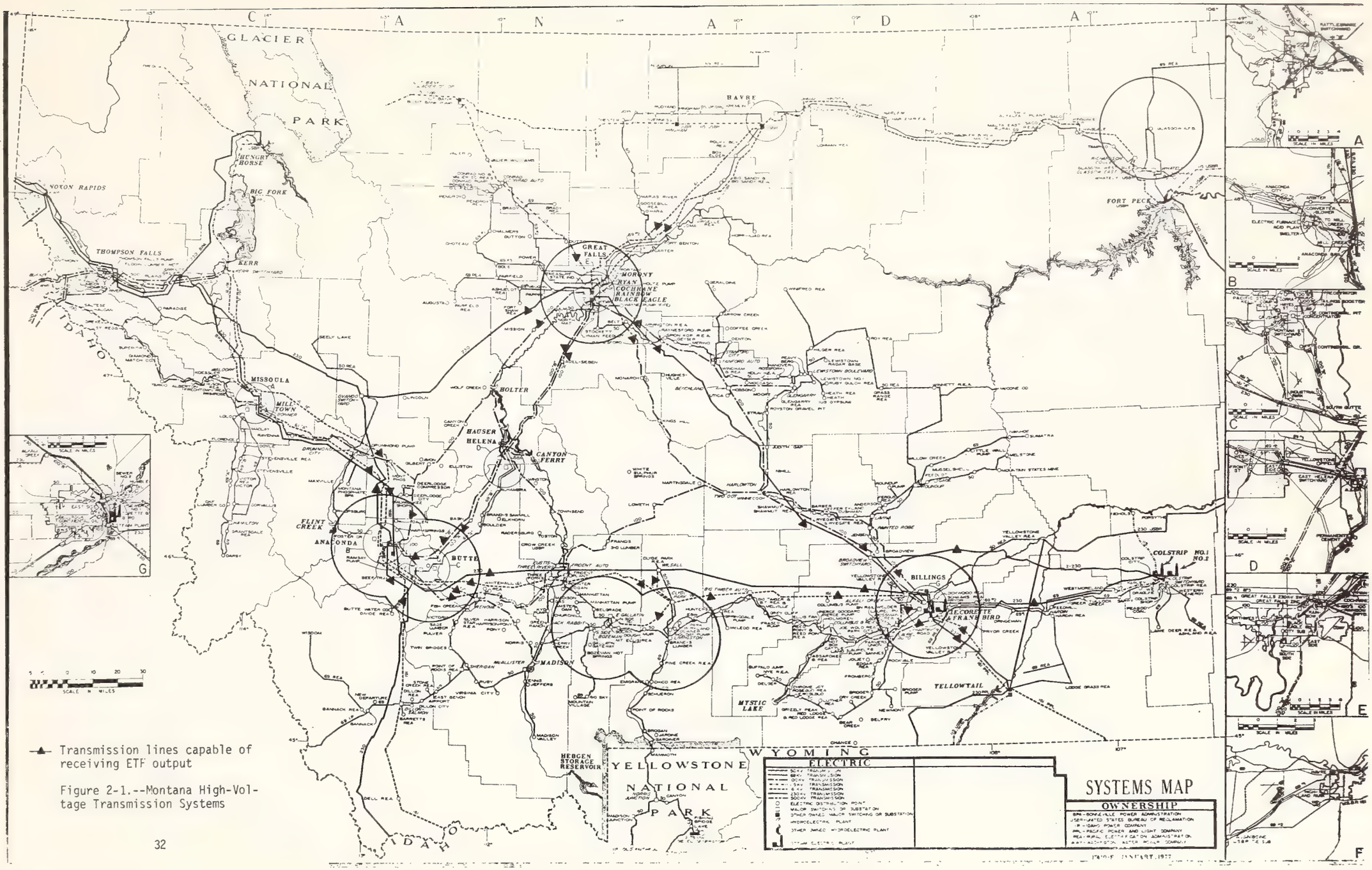
Start-up cycles may have to be limited to off-peak periods if this input is supplied by USBR. Their surplus capacity during these periods then could be utilized without disrupting their firm power commitments (Bressler, 1977).

The demand for auxiliary input has not been assigned yet; therefore, no determinations have been made with regard to a source of supply. Since this commitment would be for firm power, USBR could not be considered as a possible source.

2.5 Output Power

Transmission lines in the range of 100 to 230 KV will probably be required to transport the output energy. Available line capacities, line efficiencies, and service interruption insurance are all factors which lead to this decision by the utilities. Transmission lines within each CSA that presently can accept the 128 MW output are designated in Figure 2-1 (Bressler, 1977; Wilkerson, 1977; Lisbakken, 1977; Braun, 1977).

Currently no transmission line in the Glasgow Air Force Base (GAFB) CSA is available to receive the output. Although the USBR has constructed 115 KV, 161 KV, and 230 KV lines within this CSA, these lines already are loaded



Transmission lines capable of receiving ETF output

Figure 2-1.--Montana High-Voltage Transmission Systems

heavily with the output of hydrogeneration at Fort Peck and Yellowtail dams. At this time it would be necessary to construct an additional 230 KV transmission line between the site and a line with capacity in either the North Dakota/South Dakota area or the Havre/Great Falls area (Bressler, 1977). This situation may change; as, the Army Corps of Engineers has proposed the addition of additional peaking capacity to the Fort Peck Reservoir between 1985 and 1987 and a subsequent new transmission line to carry this load. The Draft Environmental Impact Statement on this proposed action has been released, and authorization from the Executive Branch for construction may be granted within FY 78 (Harris, 1977). Should this development proceed, it is feasible that the ETF could utilize this transmission network.

2.6 Cost

According to Table 2-2, over $55,000 per mile would be required for MPC to construct a new 230 KV transmission line. If over 10 miles of construction is needed for a line greater than 69 KV to 230 KV, a permit may be required from the Board of Natural Resources and Conservation (Montana State House of Representatives, 1975).

Table 2-2.--Cost Estimate of Typical Transmission Line Per Mile in 1976 Dollar Value[1]

Line Size (KV)	Location (type of area)	Expenses (dollars) Land Rights	Timber Clearing	Roads & Trails	Poles & Fixtures	Conductors & Devices	A.F.D.C.[2]	Total (dollars/mile)
230 KV	Rural	1,125	450	250	23,760	23,500	2,000	51,085
161 KV	Rural	1,375	450	250	19,010	15,500	1,600	38,185
161 KV	Urban	1,600	0	0	20,785	16,700	1,650	40,735
100 & 115 KV	Rural	1,375	450	250	15,885	12,300	1,000	31,660
100 & 115 KV	Urban	2,100	0	0	18,260	16,000	1,100	37,460
50 & 69 KV	Rural	1,000	250	125	11,600	7,150	500	20,625
50 & 69 KV	Urban	1,600	0	0	13,100	10,350	600	25,650

[1] add 7%/year for inflation

[2] allowance for funds during construction

Source: Duvendack, 1977.

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3.0 AIR QUALITY INVENTORY OF FIVE MONTANA CANDIDATE SITE AREAS

3.1 Introduction

This report summarizes existing data which characterizes the baseline air quality in the 5 candidate site areas (CSA's): Billings, Butte-Anaconda, Glasgow Air Force Base, Great Falls, and Livingston. Baseline ambient air quality data for the CSA's was obtained for the years 1971 through 1977 from the Montana State Department of Health and Environmental Sciences-Air Quality Bureau (AQB); this data was summarized by pollutant and by CSA through the efforts of MERDI personnel. Additional information on the baseline air quality in the CSA's may be available from local industries (MERDI supplied some data for the Butte area). Air monitoring networks in the CSA's are shown in Figures 3-1, 3-2, 3-3, and 3-4 (the Livingston area is not monitored). Figure 3-5 presents a key for the abbreviations and symbols used in the air quality tables.

Point sources of air emissions documented by the AQB are identified and quantified where information is available. To allow comparison of the air quality data with standards, state and federal ambient air quality standards are presented in Appendix I.

3.2 Billings Candidate Site Area

3.2.1 Baseline Air Quality

Billings, Montana, the largest city in Montana, has significant levels of air pollution. The following breakdown demonstrates the levels of numerous air pollutants as measured by the Montana Air Quality Bureau (AQB) in the Billings candidate site area.

3.2.1.1 Total suspended particulates

Total suspended particulate (TSP) data for the Billings area is presented in the form of annual summaries (Tables 3-1 through 3-7) for the years 1971-77 (AQB data). An annual arith-

Figure 3-1.--Billings Area

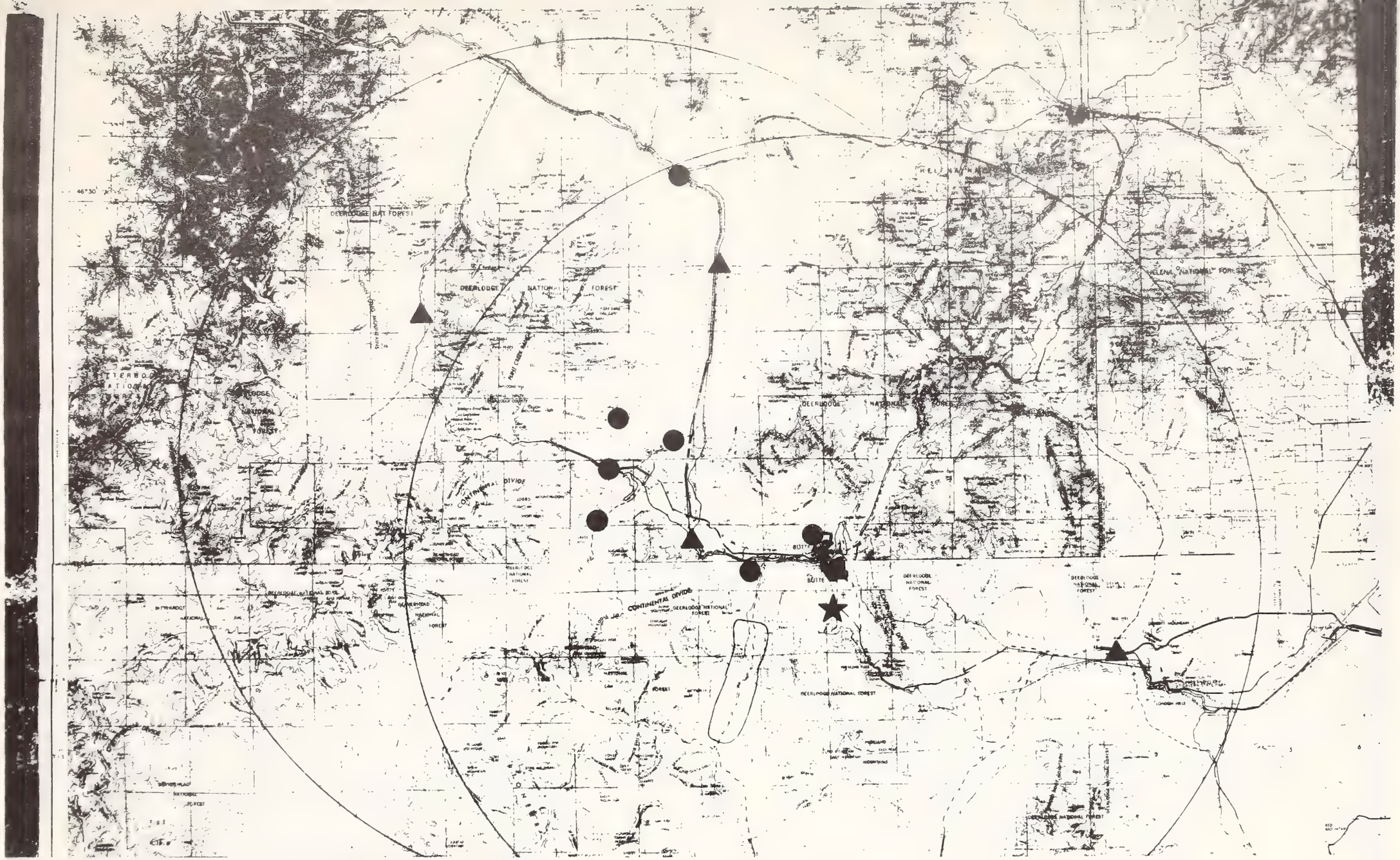

Figure 3-2.--Butte-Anaconda Area

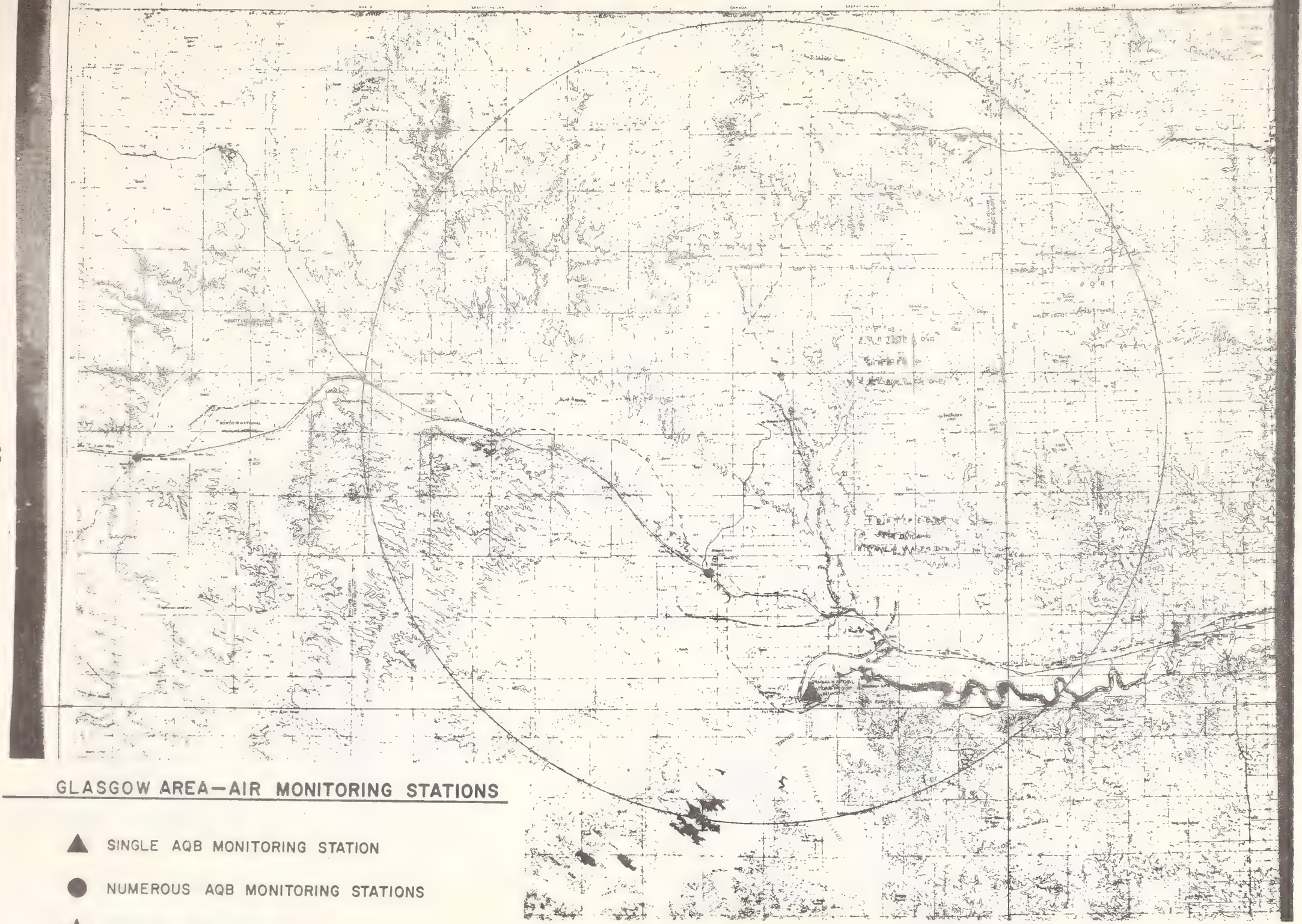

Figure 3-3.--Glasgow AFB Area

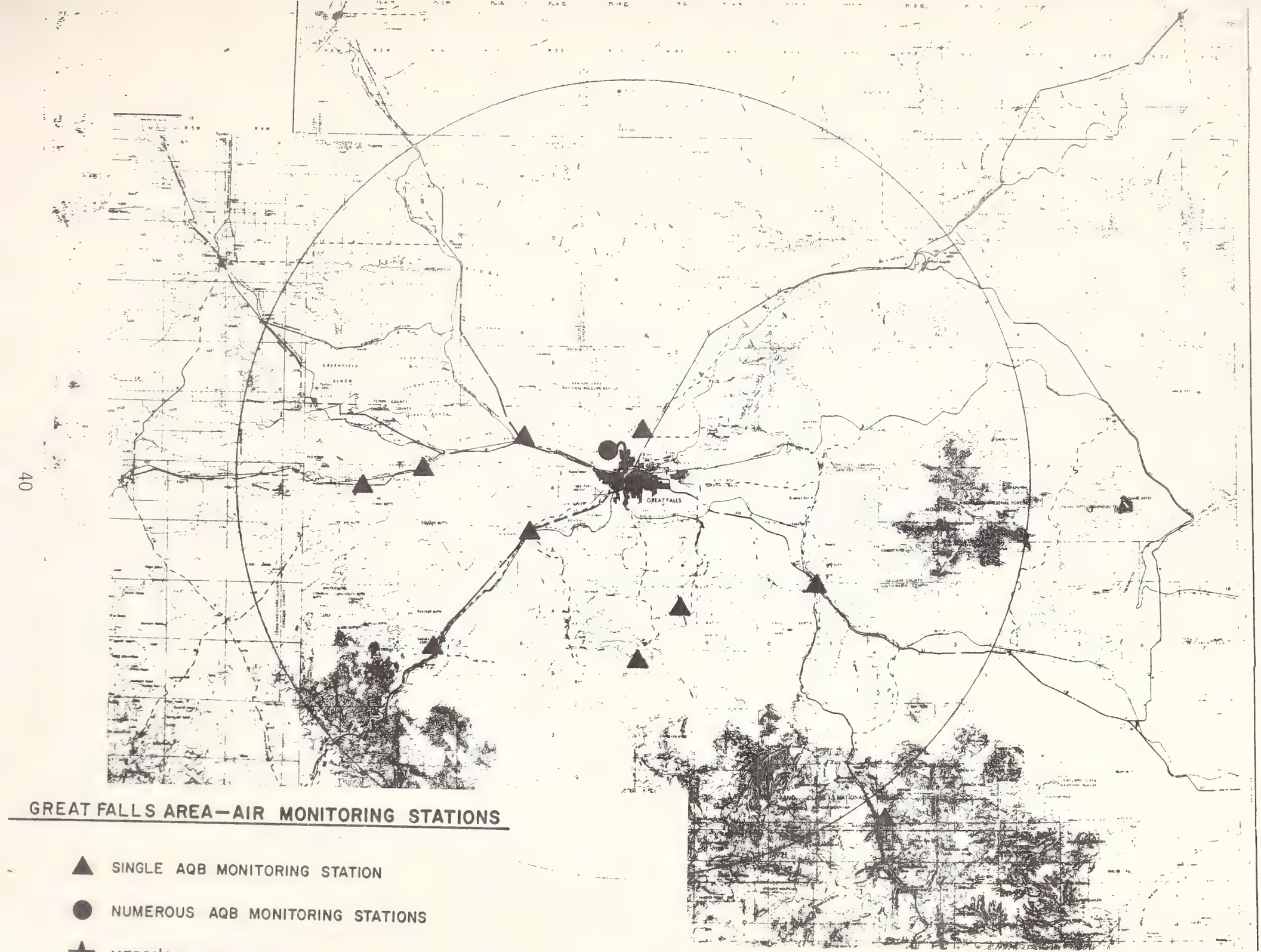

Figure 3-4.--Great Falls Area

Figure 3-5

Key for the Air Quality Tables

Abbreviation	Word
Arith.	arithmetic
Avg.	average
Dev.	deviation
Geo.	geometric
max.	maximum
mo.	month
N/A	not available
No.	number
observ.	observation
per.	periods
PPB	parts per billion
ppm	parts per million
std.	standard

Other Symbols	Word
#	number
- (dash)	parameter not measured or results not available
$\mu g/m^3$	micrograms per cubic meter
$\mu g/cm^2/30$ days	micrograms per square centimeter per 30 days
$mgSO_3/100cm^2/day$	milligrams sulfur trioxide per 100 square centimeters per day

Table 3-1

BILLINGS 1971 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

* Alert
**Warning
***Emergency

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#80005 city of Bilgs.Frgrds. Mobile Lab	152	63	53	20	29	-	-	-	-	-	-	-	-	9	9	5	6	1	0	0	0	0	0
#80007 City of Billings KGHL Sta.	145	57	50	13	32	-	-	-	-	-	-	-	3	6	7	9	7	0	0	0	0	0	0
#80008 City of Billings City Hall Station	190	81	75	5	28	-	-	-	-	-	-	-	-	2	9	9	8	1	0	0	0	0	0
#840001 Yellowstone Co. Laurel Jr. High	96	54	49	9	8	-	-	-	-	-	-	-	-	-	-	4	4	0	0	0	0	0	0
#80047 City Blgs. Swg. Trt. Plant	276	96	64	78	22	-	-	-	-	-	-	-	6	7	8	1	-	5	2	4	0	0	0
City of Billings Grand Ave. School	67	34	31	16	8	-	-	-	-	-	-	-	-	8	-	-	-	0	0	0	0	0	0
City of Billings Lockwood School	107	71	68	25	3	-	-	-	-	-	-	-	3	-	-	-	-	0	0	0	0	0	0

Table 3-2

* Alert
**Warning
***Emergency

BILLINGS 1972 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#80047 City of Blgs. Sewage Trt.Plant	115	63	59	26	6	-	-	-	-	-	-	-	-	-	-	-	6	0	0	0	0	0	0
#80049 City of Billings Water Trt. Plant	59	40	39	6	10	-	-	-	-	-	-	-	-	-	1	3	6	0	0	0	0	0	0
#680001 City of Hardin-Hardin MDU	147	66	59	3	37	-	-	-	3	4	5	4	4	4	4	5	4	0	0	0	0	0	0
#840001 Yellowstone Co. Laurel Jr. High	47	29	28	6	16	-	-	-	-	-	-	-	-	5	2	4	5	0	0	0	0	0	0
#80006 City of Billings Lockwood School	78	43	40	8	17	-	-	-	-	-	-	-	-	3	5	3	6	0	0	0	0	0	0
#80007 City of Billings KGHL Station	78	41	37	7	16	-	-	-	-	-	-	-	-	5	4	2	5	0	0	0	0	0	0
#80009 City of Billings Grand Ave. School	86	66	59	14	15	-	-	-	-	-	-	-	-	3	4	3	5	0	0	0	0	0	0

Table 3-2 (continued)

* Alert
**Warning
***Emergency

BILLINGS 1972 (Continued) SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#80008 City of Billings City Hall Station	224	99	91	16	12	-	-	-	-	-	-	-	-	3	4	5	-	2	0	1	0	0	0
#80006 City of Billings Lockwood School	62	40	39	5	20	-	5	8	6	1	-	-	-	-	-	-	-	0	0	0	0	0	0
#80008 City of Billings City Hall Station	179	83	70	18	28	7	6	8	6	1	-	-	-	-	-	-	-	4	0	0	0	0	0
#80009 City of Billings Grand Ave. School	279	110	91	47	16	-	4	6	5	1	-	-	-	-	-	-	-	4	1	3	0	0	0
#840001 Yellowstone Co. Laurel Jr. High	77	36	34	11	21	5	4	5	5	2	-	-	-	-	-	-	-	0	0	0	0	0	0
#80005 City of Billings Frgrds. Mobile Lab	247	80	71	16	83	17	22	27	17	-	-	-	-	-	-	-	-	5	0	2	0	0	0
#80007 KGHL Station, City of Billings	131	51	45	16	25	7	5	9	4	-	-	-	-	-	-	-	-	0	0	0	0	0	0

Table 3-3

BILLINGS 1973 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

* Alert
**Warning
***Emergency

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#80008 City of Billings City Hall Station	203	85	78	21	55	4	4	5	5	5	5	5	4	5	4	5	4	3	0	1	0	0	0
#80009 City of Billings Grand Ave. School	180	65	53	6	9	3	3	6	5	2	3	4	4	-	2	2	5	1	0	0	0	0	0
#840001 Yellowstone Co. Laurel Jr. High	97	48	44	1	34	1	4	4	2	1	5	2	2	4	1	3	5	0	0	0	0	0	0
#80005 City of Billings Frgrds. Mobile Lab	127	85	78	7	12	-	-	-	-	-	-	-	-	-	3	4	5	0	0	0	0	0	0
#80006 City of Billings Lockwood School	135	39	35	3	56	5	4	5	5	5	5	4	4	5	4	5	5	0	0	0	0	0	0
#80007 City of Billings KGHL Station	170	55	49	4	55	4	4	6	5	5	5	3	4	5	5	4	5	1	0	0	0	0	0
#680001 City of Hardin - Hardin MDU	257	132	111	25	41	3	4	5	4	4	5	4	5	4	3	-	-	16	0	9	0	0	0

Table 3-4

* Alert
**Warning
***Emergency

BILLINGS 1974 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#80006 City of Billings Lockwood School	112	44.8	38.5	2.98	54	4	5	4	5	5	4	3	5	3	5	5	6	0	0	0	0	0	0
#80007 City of Billings KGHL Station	94	40.5	35.3	1.20	35	-	-	-	-	-	4	5	5	5	5	5	6	0	0	0	0	0	0
#80008 City of Billings City Hall Station	144	63.8	58.7	4.54	55	5	5	5	4	5	6	5	5	5	1	3	6	0	0	0	0	0	0
#80009 City of Billings Grand Ave. School	142	68.5	59.1	4.73	56	5	4	3	5	5	6	3	5	5	5	5	5	0	0	0	0	0	0
#840001 Yellowstone Co. Laurel Jr. High School	181	35.2	29.6	4.06	55	5	5	4	5	5	-	5	5	5	5	5	6	1	0	0	0	0	0
#80005 City of Billings Frgrds. Mobile Lab	171	69.9	60.2	13.44	32	5	6	5	5	5	4	1	1	-	-	-	-	1	0	0	0	0	0
#80007 City of Billings KGHL Station	63	29	25	7	18	5	5	4	4	-	-	-	-	-	-	-	-	0	0	0	0	0	0

Table 3-5

* Alert

***Emergency

BILLINGS 1975 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$) **Warning

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#80008 City of Billings City Hall Station	157	66.3	58.9	1.27	56	5	4	6	5	5	5	4	3	5	5	5	4	2	0	0	0	0	0
#80009 City of Billings Grand Ave. School	161	65.5	57.6	1.24	50	4	4	5	3	1	5	4	5	5	4	5	5	1	0	0	0	0	0
#840001 Yellowstone Co. Laurel Jr. High	86	35.4	31.8	1.23	52	3	2	5	5	5	5	4	5	5	5	5	3	0	0	0	0	0	0
#60010 Bighorn Co. Warren Ranch	7	5.3	4.7	1.40	4	-	-	-	-	-	-	-	-	-	-	-	4	0	0	0	0	0	0
#80006 City of Billings Lockwood School	114	41.9	36.1	1.31	59	5	4	6	5	5	5	4	5	5	5	5	5	0	0	0	0	0	0
#80007 City of Billings KGHL Station	73	32.8	27.5	1.78	57	4	4	6	5	5	5	4	5	5	5	5	4	0	0	0	0	0	0

Table 3-6

* Alert

***Emergency

BILLINGS 1976 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$) **Warning

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#60010 Bighorn Co. Warren Ranch	146	32.5	24.2	1.56	55	6	4	5	5	4	4	4	4	5	5	5	4	0	0	0	0	0	0
#80006 City of Billings Lockwood School	141	52.5	45.1	1.29	51	4	5	2	5	5	6	2	5	5	5	5	2	0	0	0	0	0	0
#80007 City of Billings KGHL Station	154	37.7	32.5	1.27	55	3	5	5	5	5	6	2	5	5	4	5	5	0	0	0	0	0	0
#80008 City of Billings City Hall Station	200	69.4	63.8	1.14	53	2	5	4	4	5	6	2	5	5	5	5	5	2	0	0	0	0	0
#80009 City of Billings Grand Ave. School	199	74.0	58.0	2.06	39	4	5	1	4	4	4	2	3	3	3	2	4	1	0	0	0	0	0
#80055 Billings Burnstead Drive	1117	184.3	86.1	6.26	8	-	-	-	-	-	-	-	-	-	-	3	5	3	1	1	1	1	1
#840001 Yellowstone Co. Laurel Jr. High	108	38.3	33.5	1.30	54	5	5	5	5	5	6	2	5	5	3	5	3	0	0	0	0	0	0

Table 3-6 (continued)

* Alert
**Warning
***Emergency

BILLINGS 1976 (continued) SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#80801 Billings 28th St. W.	5398	433.8	136.5	4.43	21	-	-	-	-	-	9	2	5	1	4	-	-	10	9	10	6	4	3

Table 3-7

* Alert

***Emergency

BILLINGS 1977 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$) **Warning

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observed	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#80008 City of Billings City Hall Station	165	64.5	57.9	1.27	28	3	4	5	5	6	5	-	-	-	-	-	-	2	0	0	0	0	0
#80009 City of Billings Grand Ave. School	155	58.1	48.3	1.47	25	3	2	4	5	6	5	-	-	-	-	-	-	1	0	0	0	0	0
#80057 City of Billings 1428 8th Ave. N.	1352	1138.5	1117.3	1.06	4	-	-	-	-	-	4	-	-	-	-	-	-	4	4	4	4	4	3
#840001 Yellowstone Co. Laurel Jr. High	150	39.6	33.7	1.43	24	4	2	4	4	5	5	-	-	-	-	-	-	0	0	0	0	0	0
#60010 Bighorn Co. Warren Ranch	51	17.2	13.2	1.46	27	6	4	4	4	5	4	-	-	-	-	-	-	0	0	0	0	0	0
#80006 City of Billings Lockwood School	137	46.5	39.2	1.41	30	5	4	5	5	6	5	-	-	-	-	-	-	0	0	0	0	0	0
#80007 City of Billings KGHL Station	163	39.3	33.3	1.34	30	5	4	5	5	6	5	-	-	-	-	-	-	1	0	0	0	0	0

Table 3-7 (continued)

* Alert
**Warning
***Emergency

BILLINGS 1977 (continued) SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Stnd. Dev.	No. Observed	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m	260	200	375*	625**	875***
#80055 Billings Burnstead Drive	688	306.8	203.0	1.45	11	2	1	4	4	-	-	-	-	-	-	-	-	6	5	5	5	2	0

metic mean for all stations of 47.6 micrograms per cubic meter ($\mu g/m^3$) was measured during 1975 by the AQB.

Although the levels of TSP in the ambient air vary widely at different stations, a significant number of violations of Federal and Montana ambient air quality standards have been recorded. A tabulation of the number of violations of Federal and Montana ambient air quality standards recorded during the period of record is given in Table 3-8. As demonstrated in Table 3-8, several air quality monitoring stations in the Billings CSA have been and currently are exceeding Montana and Federal TSP ambient air quality standards.

3.2.1.2 Sulfur dioxide

Levels of sulfur dioxide (SO_2), a gas produced by the combustion of fuels containing sulfur, are measured in the Billings area by a gas bubbler and by a continuous monitoring instrument. Tables 3-9 and 3-10 present gas bubbler data, whereas Table 3-11 presents continuous monitor data. Data was available for the continuous monitor for 1975 through 1977 and for the gas bubbler for 1973 through 1977.

Table 3-12 shows the number of violations of ambient air quality standards measured at the AQB monitoring stations. Although there were a limited number of monitoring stations operating, numerous violations of state and federal standards occurred, especially in recent years (1975-77). Of the sites monitored, the Laurel area consistently has levels of SO_2 exceeding standards. The areas surrounding the oil refineries, Montana Power's Corrette Plant, and the Montana Sulfur and Chemical Company can be expected to have higher levels of SO_2 than unindustrialized sites.

TABLE 3-8

BILLINGS 1971-77 VIOLATIONS OF THE MONTANA AND FEDERAL TOTAL SUSPENDED PARTICULATE STANDARDS

Year	# Stations Operating	# Stations Exceeding Montana Standards			# Stations Exceeding Federal Standards					
					Primary			Secondary		
		Annual Geo Mean $75\mu g/m^3$	Max 24hr avg. $200\mu g/m^3$	#Days> $200\mu g/m^3$	Annual $75\mu g/m^3$	24hr $260\mu g/m^3$	#Days >260	Annual $60\mu g/m^3$	24hr. $150\mu g/m^3$	#Days >$150\mu g/m^3$
1971	7	0	1	4	0	1	2	3	3	7
1972	9	2	3	6	2	1	1	3	3	15
1973	7	3	2	10	3	0	0	3	4	21
1974	6	0	0	0	0	0	0	1	2	2
1975	6	0	0	0	0	0	0	0	2	3
1976	8	2	2	11	2	2	10	3	5	16
1977	8	2	2	9	2	2	9	2	5	14

Table 3-9

BILLINGS 1973-74 SUMMARY - SO_2 BUBBLER DATA (ppm)

Station 1974	Max. 24 hr. avg.	Arith. Mean	Geo. Mean	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 0.02	0.05	0.100	0.140	0.200	0.250
#80035 Bl. Hi-Ball Trucking	0.0622	0.0112	0.0010	24	-	-	-	-	6	9	5	-	-	-	-	4	4	1	0	0	0	0
#840005 Yels. Co. Laurel Water Plant	0.0576	0.0032	0.0000	56	2	5	6	3	5	7	7	8	7	4	-	2	2	1	0	0	0	0
#840008 Yels. Co. 3/4 mi. NE of Coop.	0.0846	0.0124	0.0017	80	6	6	7	6	7	9	8	8	7	5	5	6	16	3	0	0	0	0
#80038 Bl. Johnson Rd. North	0.0248	0.0095	0.0018	17	4	4	2	5	2	-	-	-	-	-	-	-	3	0	0	0	0	0
1973 #80038 Bl. Johnson Rd. North	0.0615	0.0160	0.0105	32	-	3	4	2	-	-	3	3	5	4	5	3	9	1	0	0	0	0
#840008 Yels. Co. 3/4 mi. NE of Coop.	0.1074	0.0303	0.0150	13	-	-	-	-	-	-	-	-	-	-	3	-	5	4	1	0	0	0
#840005 Yels. Co. Laurel Water Plant	0.0050	0.0050	0.0050	1	-	-	-	-	-	-	-	-	-	-	1	-	0	0	0	0	0	0
#80011 Bl. 33rd & 2nd Ave. North	0.0110	0.0065	0.0055	10	1	2	1	1	-	-	1	2	-	2	-	-	0	0	0	0	0	0
#840001 Yels. Co. Laurel Jr. High	0.0702	0.0174	0.0062	14	-	-	-	-	-	-	3	3	5	3	-	-	4	1	0	0	0	0
#840008 Yels. Co. 3/4 mi. NE of Coop.	0.0812	0.0273	0.0144	10	-	-	7	3	-	-	-	-	-	-	-	-	4	3	0	0	0	0
Same as above	0.0686	0.0291	0.0222	4	-	4	-	-	-	-	-	-	-	-	-	-	1	1	0	0	0	0

Table 3-10

BILLINGS 1975-77

SUMMARY - SO_2 BUBBLER DATA (ppm)

Station 1977	Max. 24 hr. avg.	Arith. Mean	Geo. Mean	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 0.02	0.05	0.100	0.140	0.200	0.250
#80006 Bl. Lockwood School	0.0611	0.0198	0.0007	18	5	1	2	5	5	-	-	-	-	-	-	-	8	2	0	0	0	0
#840009 Yels. Co. Farm E. of Cenex	0.1492	0.0664	0.0593	18	13	5	-	-	-	-	-	-	-	-	-	-	18	9	3	1	0	0
1976 #80006 Bl. Lockwood School	0.2012	0.0223	0.0018	49	5	5	5	5	5	6	1	2	3	5	4	3	15	6	3	1	1	0
#840009 Yels. Co. Laurel Farm E. of Cenex	0.2325	0.0491	0.0105	110	-	-	-	16	22	15	11	9	10	5	4	13	60	37	19	12	6	0
#840005 Yels. Co. Laurel Water Plant	0.0805	0.0227	0.0049	9	2	3	4	-	-	-	-	-	-	-	-	-	3	2	0	0	0	0
#840008 Yels. Co. 3/4 mi. NE of Coop.	0.1172	0.0259	0.0100	15	5	5	5	-	-	-	-	-	-	-	-	-	8	1	1	0	0	0
1975 #80006 Bl. Lock-wood Sch.	0.0340	0.0089	0.0007	14	-	-	-	-	-	-	-	-	-	4	5	5	2	0	0	0	0	0
#840005 Yels. Co. Laurel Water Plant	0.2176	0.0108	0.0004	52	4	4	5	5	4	4	3	5	5	4	4	5	4	2	1	1	1	0
#840008 Yels. Co. 3/4 mi. NE of Coop.	0.1095	0.0192	0.0023	52	4	2	6	5	4	5	3	5	5	5	5	3	15	7	1	0	0	0
#80035 Bl. Hi-Ball Trucking	0.1241	0.0317	0.0028	38	5	4	6	5	2	5	3	4	4	-	-	-	15	9	3	0	0	0

TABLE 3-11

BILLINGS 1975-77 SO_2 CONTINUOUS MONITOR DATA SUMMARY (ppm)

Station	Maximums 1hr.	3hr.	24hr.	Arith. Avg.	#hrs. >0.25	#3hr. per. >0.50	#24hr. per. >0.10 ppm	#24hr. per. >0.14 ppm	#24 hr. Alert >0.30	#24 hr. Warning >0.60	#24hr Emergency >0.80	#Days/Mo. sampled J	F	M	A	M	J	J	A	S	O	N	D	Total No. Days Observed
1977																								
Laurel Farm E. of Cenex	0.63	0.45	0.25	0.051	200	0	41	22	0	0	0	28	28	31	19	30	29	19	13	-	-	-	-	197
Billings 27th & Montana Avenue	0.20	0.09	0.03	0.002	0	0	0	0	0	0	0	9	19	18	27	24	15	30	26	-	-	-	-	168
1976																								
Laurel Water Plant	0.50	0.32	0.14	0.012	14	0	3	0	0	0	0	-	-	-	-	-	24	29	4	23	16	13	-	109
Laurel Farm E. of Cenex	0.80	0.61	0.38	0.061	461	4	64	38	5	0	0	-	-	-	21	31	30	31	29	19	30	21	31	243
1975																								
Lockwood School	0.23	0.18	0.08	0.011	0	0	0	0	0	0	0	14	26	27	18	29	23	30	31	29	26	4	-	257

TABLE 3-12

BILLINGS CSA 1973-77 VIOLATIONS OF THE FEDERAL AND MONTANA SULFUR DIOXIDE STANDARDS (ppm)

Year	# Stations Operating	# Stations Exceeding Montana Standards					# Stations Exceeding Federal Standards					Remarks
							Primary				Secondary	
		Annual Avg. 0.02 ppm	24hr. avg. 0.10 ppm	1hr. avg. 0.25 ppm	#Days >0.10	#1hr. periods >0.25	Annual Avg. 0.03 ppm	24hr. avg. 0.14 ppm	#Days >0.14	3hour 0.50ppm	#3hr. periods >0.50 ppm	
1973[a]	5	1	1	N/A	1	N/A	0	0	0	N/A	N/A	
1974[a]	4	0	0	N/A	0	N/A	0	0	0	N/A	N/A	
1975[+]	4	1	3	0	5	0	1	1	1	0	0	
1976[*]	4	3	4	2	71	475	1	2	39	1	4	
1977[*]	3	1	1	1	41	200	1	1	22	0	0	

[a] - data from gas bubblers only
N/A - not available - not measured by gas bubbler

[+] - only one station had continuous monitor
[*] - 2 stations with continuous monitor

3.2.1.3 Sulfation rate

Data on the sulfation rate measured at AQB monitoring stations in the Billings-Laurel area during 1975-77 is given in Tables 3-13, 3-14, and 3-15. Used as a way of measuring the quantity of reactive sulfur compounds (SO_2, SO_3, H_2S, H_2SO_4) in the air, the sulfation rate can be determined by using lead peroxide candles or sulfation plates.

Data presented in the tables indicate a significant number of violations of the Montana state standards (0.25mg $SO_3/100cm^2$/day-annual or 0.50mg $SO_3/100cm^2$/day-monthly). The monitoring stations near Laurel recorded the highest average sulfation rate values, with numerous monitoring sites frequently exceeding the Montana standards. A problem with levels of reactive sulfur in the ambient air is indicated by the yearly summaries, especially in the Laurel area.

3.2.1.4 Nitrogen dioxide

Nitrogen dioxide (NO_2), a gaseous product of high temperature combustion, is not usually considered to be a problem in Montana - there is no state standard for NO_2. However, it is a constituent of the exhaust from gasoline and diesel powered vehicles and it is emitted from many industrial processes. Table 3-16 presents the levels of NO_2 measured at two stations in Billings for the years 1974-77. No violations of the Federal primary standard-0.05 parts per million (ppm)-annual average-were recorded; however, the standard was approached several times. A source emitting large amounts of NO_2 in conjunction with heavy automobile traffic in an area, could cause standards to be exceeded.

Table 3-13

1975 Sulfation Rate Data Yearly Summary Billings Area Values
in milligrams sulfur trioxide per 100 square centimeters per day

Site	Min.	Max.	Aver.	No. Samples	Months Standard Violated	Months Site Operated
Sacrifice Cliff	0.09	0.74	0.42	5	2	Apr.-Oct.
Lockwood Sch.	0.03	1.05	0.37	12	4	Jan.-Dec.
Johnson Lane	0.03	0.69	0.28	12	2	Jan.-Dec.
KGHL Station	0.01	0.76	0.21	12	1	Jan.-Dec.
City Hall	0.01	0.73	0.16	12	1	Jan.-Dec.
Garden Avenue	0.02	0.41	0.14	12	0	Jan.-Dec.
CNR 33 & 2 Ave. N.	0.01	0.16	0.04	11	0	Jan.-Dec.
Mtn. View Blvd.	0.02	0.08	0.03	12	0	Jan.-Dec.
1200 Minn. Ave.	0.04	0.71	0.23	12	1	Jan.-Dec.
5th & S. 28th	0.02	0.26	0.07	11	0	Jan.-Dec.
S. 27th & 10 Ave. S.	0.03	0.49	0.14	11	0	Jan.-Dec.
East Conoco	0.03	0.96	0.43	12	3	Jan.-Dec.
Two Moon Park	0.04	0.64	0.29	12	1	Jan.-Dec.
Newman School	0.01	0.49	0.12	12	0	Jan.-Dec.
Klenck Lane	0.01	0.77	0.30	8	1	Jan.-Dec.
Exxon	0.18	1.26	0.57	12	5	Jan.-Dec.
Piccolo & N Ft. Rd.	0.16	1.35	0.70	10	7	Jan.-Dec.
Hi-Ball Trucking	0.15	1.37	0.72	11	7	Jan.-Dec.
Johnson & Lockwood	0.09	1.43	0.54	12	7	Jan.-Dec.
Johnson Rd. N.	0.10	2.17	0.72	12	8	Jan.-Dec.
Woodland	0.07	0.91	0.50	10	5	Jan.-Dec.
Coburn Road	0.14	1.50	0.64	12	9	Jan.-Dec.
Laurel Jr. Hi.	0.0	0.04	0.02	10	0	Jan.-Dec.
1 Mi. NE Coop	0.04	1.64	0.47	12	6	Jan.-Dec.
3/4 Mi. W of Coop	0.03	0.94	0.38	12	3	Jan.-Dec.
Laurel Water Plant	0.05	1.76	0.51	12	5	Jan.-Dec.
E. of Laurel	0.09	2.88	1.03	12	10	Jan.-Dec.
3/8 Mi. NE of Coop	0.90	3.62	1.72	12	12	Jan.-Dec.
Root Beer Stand	0.03	0.57	0.14	9	1	Jan.-Sep.
West Coop	0.01	0.38	0.09	12	0	Jan.-Dec.

Table 3-14

1976 Sulfation Rate Data Yearly Summary Billings Area Values
in milligrams sulfur trioxide per 100 square centimeters per day

Site	Max.	Annual Aver.	No. Samples	Months Standard Exceeded	1975 Aver.
Sacrifice Cliff	1.21	0.74	7	4	0.42
Lockwood Sch.	1.26	0.78	8	7	0.37
Johnson Lane	1.05	0.57	12	7	0.28
KGHL Station	0.72	0.32	12	3	0.21
City Hall	0.42	0.16	12	0	0.16
Garden Avenue	0.07	0.03	12	0	0.14
CNR 33 & 2 Ave. N.	0.16	0.04	10	0	0.04
Mtn. View Blvd.	0.40	0.09	11	0	0.03
1200 Minn. Ave.	1.49	0.53	12	5	0.23
5th & S. 28th	0.45	0.10	12	0	0.07
S. 27th & 10 Ave. Sl.	0.48	0.18	11	0	0.14
East Conoco	0.91	0.35	12	4	0.43
Two Moon Park	0.86	0.41	11	4	0.29
Newman School	0.63	0.18	11	1	0.12
Klenck Lane	1.19	0.44	8	3	0.30
Exxon	1.64	0.82	12	10	0.57
Piccolo & N Ft. Rd.	1.58	0.97	11	9	0.70
Hi-Ball Trucking	1.41	0.88	11	9	0.72
Johnson & Lockwood	2.15	0.74	12	6	0.54
Johnson Rd. N.	2.04	0.98	11	7	0.72
Woodland	1.17	0.77	12	10	0.50
Coburn Road	1.65	0.92	11	8	0.64
Laurel Jr. Hi.	0.04	0.02	12	0	0.02
1 Mi. NE Coop	2.02	0.83	11	6	0.47
3/4 Mi. W of Coop	1.25	0.58	11	6	0.38
1/2 Mi. S of Cenex	1.56	0.72	11	7	
E. of Laurel	3.62	1.47	12	11	1.03
Laurel Farm E. Cenex	4.80	2.65	11	10	1.72
Laurel Water Plant	0.09	0.06	2	0	0.51
West Coop	0.91	0.23	12	2	0.23

Table 3-15

1977 Sulfation Rate Yearly Summary- Billings Area. (milligrams $SO_3/100cm^2/day$)

Site	Max.	Annual Average	No. Samples	Months Std. Exceeded	Months Site Operated
#0080002 Yellowstone Co. Sacrifice Cliff	0.730	0.437	3	1	May-July
#0080004 Yellowstone Co. Johnson Lane	1.550	0.628	6	3	Jan.-July
#0080006 Yellowstone Co. Lockwood School	1.710	0.607	6	2	Jan.-July
#0080007 Yellowstone Co. KGHL Station	0.740	0.349	7	2	Jan.-Aug.
#0080008 Yellowstone Co. City Hall Station	0.570	0.270	7	1	Jan.-Aug.
#0080010 Yellowstone Co. Garden Avenue	0.430	0.179	7	0	Jan.-Aug.
#0080011 Yellowstone Co. CNR 33 & 2 Ave. N.	0.420	0.096	7	0	Jan.-Aug.
#0080014 Yellowstone Co. Mtn. View Blvd.	0.490	0.213	7	0	Jan.-Aug.
#0080017 Yellowstone Co. 1200 Minn. Avenue	1.060	0.534	7	4	Jan.-Aug.
#0080018 Yellowstone Co. 5th & S. 28th	0.600	0.233	7	1	Jan.-Aug.

Table 3-15 (continued)

1977 Sulfation Rate Yearly Summary- Billings Area (milligrams $SO_3/100cm^2/day$)

Site	Max.	Annual Average	No. Samples	Months Std. Exceeded	Months Site Operated	
#0080019 Yellowstone Co. S. 27th & 10th Ave. S.	0.930	0.410	7	2	Jan.-Aug.	
#0080021 Yellowstone Co. East Conoco	1.120	0.490	7	3	Jan.-Aug.	
#0080022 Yellowstone Co. Two Moon Park	1.200	0.669	7	6	Jan.-Aug.	
#0080027 Yellowstone Co. Newman School	0.580	0.277	4	1	Jan.-Aug.	
#0080032 Yellowstone Co. Klenck Lane	1.040	0.396	5	1	Jan.-July	
#0080033 Yellowstone Co. Exxon	1.460	1.053	6	6	Jan.-July	
#0080034 Yellowstone Co. Piccolo & N. Ft. Rd.	1.780	0.973	6	4	Jan.-July	
#0080035 Yellowstone Co. Hi-Ball Trucking	1.840	1.138	6	6	Jan.-July	
#0080037 Yellowstone Co. Johnson & Lockwood	1.880	0.910	6	4	Jan.-July	
#0080038 Yellowstone Co. Johnson Road N.	1.850	1.078	6	6	Jan.-July	

Table 3-15 (continued)

1977 Sulfation Rate Yearly Summary- Billings Area. (milligrams $SO_3/100cm^2/day$)

Site	Max.	Annual Average	No. Samples	Months Std. Exceeded	Months Site Operated	
#0080043 Yellowstone Co. Woodland	1.450	0.822	6	5	Jan.-Aug.	
#0080044 Yellowstone Co. Coburn Road	1.710	0.810	6	5	Jan.-Aug.	
#0084001 Yellowstone Co. Laurel Jr. High	0.210	0.077	6	0	Jan.-Aug.	
#0840003 Yellowstone Co. 1 Mi. NE of Coop.	2.620	0.947	7	4	Jan.-Aug.	
#0840004 Yellowstone Co. 3/4 Mi. W. of Coop.	1.480	0.816	7	5	Jan.-Aug.	
#0840005 Yellowstone Co. ½ Mi. S. of Coop.	1.750	1.116	7	7	Jan.-Aug.	
#0840008 Yellowstone Co. E. of Laurel	3.220	1.720	7	7	Jan.-Aug.	
#0840009 Yellowstone Co. 3/8 Mi. NE of Coop.	4.380	2.289	7	7	Jan.-Aug.	
#0840013 Yellowstone Co. West Coop.	0.520	0.317	7	2	Jan.-Aug.	

TABLE 3-16

BILLINGS 1974-77 NO_2 CONTINUOUS MONITOR SUMMARY (ppm) Hourly Readings

Station	Maximum 1hr.	3hr.	24hr.	Arith. Avg.	#hr.per >0.02	#hr. per. >0.03	#hr. per. >0.05	#hr per. >0.10	#hr per >0.50	#hr per >0.80	#hr per. >1.00	Total #days Sampled	#Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	Total Readings
1977																									
27th & Montana	0.08	0.07	0.04	0.010	205	130	9	0	0	0	0	38	11	4	0	13	10	-	-	-	-	-	-	-	778
1976																									
27th & Montana	0.11	0.10	0.07	0.034	4524	3218	1046	6	0	0	0	214	28	29	29	27	30	30	30	11	0	0	0	0	5346
1975																									
27th & Montana	0.10	0.10	0.07	0.041	1041	831	349	2	0	0	0	50	-	-	-	-	-	-	-	-	-	-	21	29	1095
#1 Grand Avenue	0.13	0.06	0.0	0.010	N/A	N/A	N/A	N/A	N/A	N/A	N/A	208	31	28	28	30	31	30	30	-	-	-	-	-	4704
1974																									
#1 Grand Avenue	0.05	0.04	0.0	0.016	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7	-	-	-	-	-	-	-	-	-	-	-	7	125

N/A - Not Available

3.2.1.5 Carbon monoxide

Levels of carbon monoxide (CO) in the Billings area ambient air during the years 1974-77 are presented in Table 3-17. CO is a product of automobile exhausts, oil refineries, and other combustion processes. Again, there are no state standards, but the pollutant is measured in Billings because of the auto density and a number of point sources. The AQB measurements show several violations of the 8-hour federal primary standard during 1975 and 1976; however, no violations had occurred up through April of 1977.

3.2.1.6 Hydrocarbons

Table 3-18 shows a yearly summary of the levels of hydrocarbons (HC) measured in the Billings CSA during the years 1975-77. Hydrocarbons are emitted by automobiles, oil refineries, and other processes using organic fuels. In the Billings area, the oil refineries are large sources of hydrocarbons; moreover, the high density of automobiles in the area adds to the HC levels.

According to Hal Robbins, AQB, the natural background level of HC in the ambient air is approximately 0.15 ppm; any increase above this indicates pollution by man-made sources. As with NO_2 and CO, there are no Montana ambient air quality standards for hydrocarbons, but a federal primary standard exists (0.24 ppm for a 3 hour average from 6-9 a.m.). Since this standard is for non-methane hydrocarbons and the state measures total hydrocarbons, no direct comparison between the levels in Table 3-18 and the federal primary standard can be made. However, increases in hydrocarbons above the natural background levels can be noted. The AQB data indicates substantial levels of HC's in

Table 3-17

1974-77 BILLINGS SUMMARY-CARBON MONOXIDE (CO) CONTINUOUS MONITOR DATA (ppm)

Station 1977	Arith. Avg.	Maximums 1 hr.	3 hr.	8 hr.	No. 1 hr. periods >[illegible].00	>15.00	>25.00	>35.00	No. 8 hr. per. >3.00	>6.00	>9.00	No. Days Data	No. Days Data/mo. J	F	M	A	M	J	J	A	S	O	N	D
27th & Montana	2.909	13.50	11.67	8.63	164	0	0	0	87	8	0	66	29	24	0	13	-	-	-	-	-	-	-	-
1976																								
27th & Montana	2.363	27.50	21.50	14.63	704	22	2	0	298	26	5	306	30	29	26	29	18	11	-	21	30	28	30	24
11th & 27th St.	0.511	9.00	6.60	4.61	28	0	0	0	5	0	0	191	31	29	31	30	29	5	-	5	-	-	-	-
1975																								
27th & Montana Ave.	3.212	26.50	17.50	13.12	407	18	1	0	149	21	5	97	-	-	-	-	-	-	-	-	15	31	22	29
#1 Grand Avenue	1.645	17.00	13.33	10.19	274	3	0	0	111	9	2	201	29	26	28	30	29	29	30	-	-	-	-	-
11th & 27th St.	0.846	9.00	5.90	4.61	12	0	0	0	4	0	0	46	-	-	-	-	-	-	-	-	-	-	15	31
1974																								
#1 Grand Avenue	1.61	5.50	3.50	2.31	1	0	0	0	0	0	0	2	-	-	-	-	-	-	-	-	-	-	-	2

Table 3-18

BILLINGS 1975-77 HYDROCARBONS (HCx) YEARLY SUMMARY (ppm)

Station	Arith. Average	Maximums 1 hr.	3 hr.	24 hr.	No. 3 hour periods >0.24	>1.00	>2.00	>4.00	>8.00	No. Days Data	No. Samples-Days/mo. J	F	M	A	M	J	J	A	S	O	N	D
1977																						
27th & Montana	2.156	6.90	5.00	2.99	493	466	301	7	0	69	10	0	8	26	25	-	-	-	-	-	-	-
1976																						
27th & Montana	2.690	10.20	8.50	4.52	1963	1928	1604	95	1	271	23	25	24	23	20	20	5	24	26	26	30	25
Laurel E. of Cenex	1.999	6.60	5.40	2.70	529	519	182	2	0	71	-	-	-	-	22	30	19	-	-	-	-	-
11th & South 27th Street	2.405	8.40	7.90	3.74	368	358	228	21	0	54	10	28	16	-	-	-	-	-	-	-	-	-
1975																						
27th & Montana	4.365	30.00	30.00	25.67	696	685	621	214	102	89	-	-	-	-	-	-	-	-	10	24	26	29
#1 Grand Avenue	2.533	5.40	5.00	3.55	N/A	N/A	N/A	N/A	N/A	50	-	-	-	-	-	29	21	-	-	-	-	-
#1 Grand Avenue	2.551	10.00	9.50	3.64	N/A	N/A	N/A	N/A	N/A	81	-	-	24	27	30	-	-	-	-	-	-	-

the Billings area.

3.2.1.7 Ozone

Ozone, a well known constituent of photochemical smog, is also measured in the city of Billings. Levels of ozone (O_3) measured at two sites in the city during the period 1974 to 1977 are presented in Table 3-19. Although no state standards exist, the federal primary and secondary standard for photochemical oxidants (0.08 ppm for a 1 hour average) applies to O_3.

No violations of the federal ambient air quality standard had occurred through May 1977 at the monitoring sites; however, numerous violations were recorded during 1975 and 1976. The effect of an MHD facility on the O_3 levels in the ambient air is unknown.

3.2.2 Emission Sources

3.2.2.1 Point sources

A number of industrial sources of air pollution are present in the Billings-Laurel area. Table 3-20 indicates the major point sources and their emissions in tons per year during 1976.

Other than the Montana Power Company Corrette Plant in Billings, the largest emission sources in the area are the three oil refineries (Conoco, Exxon, and Cenex) which emit large quantities of particulates, sulfur dioxide, nitrogen dioxide, hydrocarbons, and in one case large quantities of carbon monoxide. The Corrette Power Plant releases large amounts of sulfur dioxide, particulates, and oxides of nitrogen (NOx). Although the Great Western Sugar Company and the Montana Sulphur and Chemical Company are smaller sources, they contribute to the overall air

Table 3-19

BILLINGS 1974-77 O_3 (OZONE) CONTINUOUS MONITOR YEARLY SUMMARY (ppm) (Hourly)

Station	Arith. Avg.	Maximums 1hr.	3hr.	24hr.	No. 1 hr. periods over 0.01	0.02	0.04	0.06	0.08	0.10	0.16	No. Days Data	No. Days Data/mo. J	F	M	A	M	J	J	A	S	O	N	D	Total Readings taken
1977																									
27th & Montana	0.019	0.06	0.06	0.04	1855	1566	214	0	0	0	0	143	31	28	31	26	27	--	--	--	--	--	--	--	3172
1976																									
27th & Montana	0.017	0.10	0.09	0.05	4136	3446	723	71	13	1	0	359	31	29	31	29	31	27	31	31	30	31	29	30	7966
1975																									
27th & Montana	0.011	0.09	0.07	0.02	753	503	16	4	2	0	0	101	--	--	--	--	--	--	--	--	13	31	26	31	2268
#1 Grand Avenue	0.035	0.16	0.15	0.00	3372	3169	2111	869	106	19	0	205	31	28	30	30	31	30	24	1	--	--	--	--	4668
1974																									
#1 Grand Avenue	0.022	0.05	0.05	0.00	165	139	50	0	0	0	0	13	--	--	--	--	--	--	--	--	--	--	--	13	268

Table 3-20

BILLINGS-LAUREL AREA MAJOR EMISSION SOURCES-1976 (values in Tons/year)

Point Source	Sulfur Dioxide (SO_2)	Particulates	Nitrogen Oxides (NO_x)	Hydrocarbons (HC)	Carbon Monoxide (CO)	Fluorides (F)
Cenex Refinery Laurel	11,830	398	540	1,082	31	3
Conoco Refinery Billings	2,584	263	1,041	1,936	53,874	3
Exxon Refinery Billings	9,800	932	1,401	1,132	2	3
Great Western Sugar Co. Billings	815	65	337	2	11	Neg.
Montana Power Co. Billings	12,733	1,726	6,757	113	375	9
Montana Sulphur & Chemical Co. Billings	2,000	Neg.	4	Neg.	Neg.	--
Area Sources - Yellowstone Co.						
Unpaved Roads	---	44,900				
Agriculture	---	3,061				
Other	1,545	2,215				

Source: Gelhaus, 1977.

pollution load.

The ambient air in the Billings area has a substantial amount of pollutants to handle; therefore, future industrial development may degrade the air quality in the metropolitan area to an undesirable point.

3.2.2.2 Non-point sources

Numerous non-point sources, such as farming, cattle ranching, coal mining, oil and gas production, and transportation, are present in or adjacent to the Billings CSA (Gelhaus, 1976). Table 3-20 quantifies the particulates and sulfur dioxide released from unpaved roads, agriculture, and other sources in Yellowstone County per year. On site air quality monitoring will be necessary to determine the effect of non-point sources on a specific site.

3.3 Butte-Anaconda Candidate Site Area

3.3.1 Baseline Air Quality

Historically, the Butte-Anaconda CSA has been plagued with air pollution problems. Early day mining and smelting activities resulted in large amounts of air pollution. Although an awareness of the problem and the use of air pollution control equipment on existing sources has helped, several pollutants are still exceeding state and federal ambient air quality standards.

Butte and Anaconda are separated by a considerable distance (approximately 30 miles); however, some exchange of air pollutants may occur between the two areas. Therefore, the two overlapping candidate site areas will be evaluated jointly in this report.

Air quality data for the 2 areas is available from three sources: the Air Quality Bureau (AQB), the Anaconda Company, and MERDI. At the

time of this report, no data was received from the Anaconda Company; therefore, the AQB measurements and a limited amount of MERDI's data was used as a basis for this air quality summary.

3.3.1.1 Total suspended particulates

Total suspended particulate (TSP) data for the Butte-Anaconda CSA during the period 1971-77 is presented in Tables 3-21 through 3-27. This data is predominantly from AQB monitoring stations; however, Table 3-27 contains MERDI's Met Station TSP data for February-June of 1977. Table 3-28 lists the number of violations of state and federal standards during the years of record.

As demonstrated in Table 3-28, the air quality in the Butte-Anaconda area has generally been improving in recent years. However, a significant number of violations of state and federal standards are still occurring. For example, the Greeley School monitoring station in Butte, which has consistently shown high levels of TSP, recorded a geometric mean of 92.5 micrograms per cubic meter ($\mu g/m^3$) and a maximum 24-hour reading of 285 $\mu g/m^3$ during 1976. Both of these levels are well above applicable federal and state standards.

According to AQB data, Anaconda generally has lower levels of TSP in the ambient air than Butte; however, standards are still occasionally violated. For example, the Highway Junction monitoring station near Anaconda recorded several violations of the federal and state 24-hour standard during 1976. Since fewer TSP monitoring stations have been operating in the Anaconda area than in the Butte area during recent years, the above conclusion

Table 3-21

Butte-Anaconda 1971 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

* Alert
**Warning
***Emergency

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#20005 City Anaconda Anaconda Jr. High	249	60	52	10	95	-	8	11	9	10	9	8	1	10	9	9	11	3	0	1	0	0	0
#380001 City Deerlodge Powell Co. Courthouse	201	72	59	4	54	-	-	-	-	-	1	9	7	11	7	10	9	5	0	1	0	0	0
#1260005 Powell Co. Lahmans	328	70	51	1	85	-	-	-	1	10	18	10	9	10	10	7	10	7	1	3	0	0	0
#1480007 Silver Bow Co. Ramsay School	219	62	56	10	61	-	6	8	2	5	9	1	7	6	7	4	6	2	0	1	0	0	0
#400022 Deerlodge Co. Bailey Residence	93	44	36	7	7	-	-	-	-	-	-	-	-	-	3	4	-	0	0	0	0	0	0
#160005 Butte Greely Station	365	105	85	26	41	-	-	-	-	-	-	8	9	10	8	6	-	9	2	3	0	0	0
#160006 Butte Courthouse Sta.	381	95	74	46	75	-	6	4	6	7	9	10	10	10	8	5	-	12	5	6	2	0	0

Table 3-21 (continued)

* Alert
**Warning
***Emergency

Butte-Anaconda 1971 (continued) SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#400021 Deer Lodge Co. Wally Johnson Residence	235	59	49	34	31	-	-	-	-	-	4	9	4	3	7	4	-	1	0	1	0	0	0
#160001 Butte Harrison St. Fire Sta.	319	99	88	5	37	-	-	-	-	-	-	5	9	10	9	4	-	5	1	2	0	0	0
#160002 Butte Webster Garfield School	537	101	82	20	40	-	-	-	-	-	-	7	10	10	9	4	-	4	2	2	1	0	0
#160003 Butte Silver Bow General Hosp.	402	98	80	11	38	-	-	-	-	-	-	6	8	10	9	5	-	5	2	3	1	0	0
#400001 Deer Lodge Co. S & N Cement	53	48	48	5	2	-	-	-	-	-	-	-	-	-	2	-	-	0	0	0	0	0	0
No # City Butte Old Emerson School	282	107	92	7	40	-	9	9	10	9	1	1	-	-	-	-	-	10	1	2	0	0	0
No # Deer Lodge Co. Wally Johnson Residence	100	53	49	26	6	-	-	-	-	6	-	-	-	-	-	-	-	0	0	0	0	0	0

Table 3-21 (continued)

* Alert
**Warning
***Emergency

Butte-Anaconda 1971 (continued) SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
City Butte Webster-Garfield School	270	125	106	55	29	-	-	9	4	6	10	-	-	-	-	-	-	10	1	6	0	0	0
No # City Butte Whittier School	323	149	130	42	32	-	9	9	7	7	-	-	-	-	-	-	-	15	1	10	0	0	0
No # City Butte Greeley Sta.	371	152	134	57	21	-	6	7	7	1	-	-	-	-	-	-	-	10	1	6	0	0	0
No # City Deer-lodge City Hall	237	71	50	69	10	-	9	1	-	-	-	-	-	-	-	-	-	2	0	1	0	0	0
No # Deer Lodge Co. Wally Johnson Residence	28	28	28	0	1	-	-	1	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0

Table 3-22

* Alert
**Warning
***Emergency

BUTTE-ANACONDA 1972 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#0400003 City of Anaconda Kuceras	36	11	6	12	7	-	-	-	-	-	-	-	-	-	-	-	7	0	0	0	0	0	0
#640005 Granite Co. McKinley Res.	337	101	81	18	88	-	-	-	8	10	10	11	10	10	10	9	10	17	2	6	0	0	0
#1260005 Powell Co. Lahmans	163	49	40	8	110	10	10	10	10	10	10	6	10	7	10	10	7	1	0	0	0	0	0
#20006 City of Anaconda Kirkeby	208	46	43	10	75	-	-	-	9	10	9	11	10	9	10	7	-	1	0	1	0	0	0
#160010 City of Butte McQueens Addition	528	231	194	152	12	-	-	5	7	-	-	-	-	-	-	-	-	3	2	3	1	0	0
#400001 Deer Lodge Co. S & N Cement	309	106	68	110	11	-	-	11	-	-	-	-	-	-	-	-	-	2	2	2	0	0	0
#20005 City of Anaconda Anac. Jr. High	134	39	32	15	24	6	9	9	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0

Table 3-22 (continued)

* Alert
**Warning
***Emergency

BUTTE-ANACONDA 1972 (cont'd.) SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#160001 Butte Harrison St. Fire Station	483	142	108	123	11	-	7	4	-	-	-	-	-	-	-	-	-	4	1	1	1	0	0
#160002 Butte Webster Garfield School	239	99	88	28	14	-	5	9	-	-	-	-	-	-	-	-	-	2	0	1	0	0	0
#160003 Butte Silver Bow Gen'l. Hospital	100	60	53	16	8	-	4	4	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
#160006 Butte Courthouse Station	195	98	77	27	9	-	2	7	-	-	-	-	-	-	-	-	-	2	0	0	0	0	0
#380001 City of Deer Lodge Powell Co. Courthouse	92	41	33	11	25	8	8	9	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
#1480007 Silver-Bow Co. Ramsay School	93	48	42	10	17	4	6	7	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
#160005 Butte Greeley Station	197	89	73	25	14	-	5	9	-	-	-	-	-	-	-	-	-	3	0	0	0	0	0

Table 3-23

* Alert
**Warning
***Emergency

Butte-Anaconda 1973 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#160011 City Butte Atkins	168	46	32	2	47	-	-	-	-	-	2	6	9	10	10	5	5	1	0	0	0	0	0
#640005 Granite Co. McKinley Residence	307	94	73	17	109	10	9	11	10	10	10	10	11	10	10	3	5	19	1	7	0	0	0
#1260005 Powell Co. Lahmans	211	46	36	6	92	9	4	10	10	8	9	9	9	10	8	5	1	1	0	1	0	0	0
#0400003 City Anaconda Kuceras	89	28	22	6	45	10	9	11	6	8	1	-	-	-	-	-	-	0	0	0	0	0	0

Table 3-24

* Alert
**Warning
***Emergency

Butte-Anaconda 1974 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#160005 Butte Greeley School	966	147.3	116.9	5.55	83	-	2	8	9	7	8	8	9	8	8	8	8	25	8	13	3	1	1
#160011 City Butte Atkins	177	53.9	40.1	5.32	56	5	3	6	5	5	3	5	5	5	5	4	5	2	0	0	0	0	0
#160013 Butte Hillcrest	128	42.7	37.7	1.16	63	-	-	-	-	1	11	4	14	9	3	8	8	0	0	0	0	0	0
#640005 Granite Co. McKinley Residence	199	76.2	64.9	4.28	59	5	5	5	5	5	5	5	5	5	5	5	4	4	0	0	0	0	0
#1260005 Powell Co. Lahmans	273	83.5	59.0	3.42	43	1	5	4	5	3	3	4	4	4	1	5	4	6	1	2	0	0	0
#1480014 Silver Bow Co. Columbia Gardens	179	50.5	41.9	3.27	83	-	2	8	8	9	7	9	9	8	8	8	7	2	0	0	0	0	0
#400905 Deer Lodge Co. Tailings Pond.	60	30.7	26.8	1.52	8	-	-	-	-	-	-	-	5	3	-	-	-	0	0	0	0	0	0

Table 3-24 (continued)

* Alert
**Warning
***Emergency

Butte-Anaconda 1974 (continued) SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#160012 Butte Harrison School	350	131	115	23	30	-	3	10	9	8	-	-	-	-	-	-	-	11	1	2	0	0	0

Table 3-25

* Alert
**Warning
***Emergency

Butte-Anaconda 1975 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observed	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#400004 Deer Lodge Co. HiWay Jct.	69	69.0	69.0	1.00	1	-	-	-	-	-	-	-	-	-	-	-	1	0	0	0	0	0	0
#640005 Granite Co. McKinley Residence	113	38.1	30.2	1.55	56	3	4	6	5	5	5	5	4	5	5	5	4	0	0	0	0	0	0
#160003 Butte Silver Bow General Hospital	63	63.0	63.0	1.00	1	-	-	-	-	-	-	-	-	-	-	-	1	0	0	0	0	0	0
#160005 Butte Greeley School	368	119.8	100.2	1.40	80	5	9	11	8	9	8	9	1	8	4	6	2	22	4	8	0	0	0
#160011 City Butte Atkins	242	56.6	43.4	1.57	53	2	4	6	5	4	5	5	5	5	3	5	4	2	0	1	0	0	0
#160014 Silver Bow Co. Richer Residence	54	19.5	17.7	1.15	51	-	-	-	-	4	8	8	9	9	5	6	2	0	0	0	0	0	0
#1480015 Silver Bow Co. Tierney Residence	136	37.8	31.0	1.38	53	-	-	-	-	2	8	8	9	9	7	6	4	0	0	0	0	0	0

Table 3-25 (continued)

* Alert
**Warning
***Emergency

Butte-Anaconda 1975 (continued) SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#1260018 Powell Co. Gerdts	183	79.2	65.5	1.50	45	3	4	6	5	5	5	5	5	5	2	-	-	3	0	0	0	0	0
#160003 Butte Silver Bow General Hospital	98	57.0	53.7	1.14	38	-	-	-	-	4	7	9	9	9	-	-	-	0	0	0	0	0	0
#760008 Jefferson Co. Cardwell-Whitehall	419	227.5	183.4	1.77	16	-	-	-	-	-	-	-	7	9	-	-	-	12	7	9	2	0	0
#1260005 Powell Co. Lahmans	153	72.8	62.7	1.21	22	4	4	-	-	1	-	3	-	-	-	-	-	1	0	0	0	0	0
#160013 Butte Hillcrest	111	40.9	34.4	1.48	34	5	7	10	8	4	-	-	-	-	-	-	-	0	0	0	0	0	0
#1480014 Silver Bow Co. Columbia Gardens	69	29.9	25.8	1.48	35	5	8	10	8	4	-	-	-	-	-	-	-	0	0	0	0	0	0

Table 3-26

* Alert

**Warning

***Emergency

Butte-Anaconda 1976 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#160003 Butte Silver Bow General Hospital	173	59.3	53.5	1.21	52	4	4	6	5	5	5	5	5	3	6	2	2	1	0	0	0	0	0
#160011 City Butte Atkins	306	58.0	45.4	1.47	48	4	4	6	5	5	3	4	5	2	6	2	2	2	1	1	0	0	0
#160014 Silver Bow Co. Richer Residence	42	19.6	17.8	1.18	51	4	4	6	5	5	5	4	5	3	6	2	2	0	0	0	0	0	0
#640005 Granite Co. McKinley Residence	147	40.0	24.2	4.10	57	6	4	5	5	6	5	5	3	4	4	5	5	0	0	0	0	0	0
#1480015 Silver Bow Co. Tierney Residence	202	37.0	31.3	1.42	50	4	4	6	5	5	5	3	5	3	6	2	2	1	0	1	0	0	0
#160005 Butte Greeley School	285	106.5	92.5	1.34	43	4	4	6	5	5	5	4	3	3	4	-	-	10	1	2	0	0	0
#400004 Deer Lodge Co. Hiway Jct.	250	51.0	40.9	1.33	53	6	4	6	5	4	4	5	4	4	5	1	5	2	0	1	0	0	0

Table 3-27

Butte-Anaconda 1977 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

* Alert
**Warning
***Emergency

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m^3	260	200	375*	625**	875***
#400004 Deer Lodge Co. HiWay Jct.	121	46.4	36.8	2.11	24	5	4	4	5	6	-	-	-	-	-	-	-	0	0	0	0	0	0
#640005 McKinley Residence	90	37.9	27.0	2.58	21	4	3	5	3	6	-	-	-	-	-	-	-	0	0	0	0	0	0
#160003 Butte Silver Bow General Hospital	210	89.4	74.1	1.47	12	4	4	4	-	-	-	-	-	-	-	-	-	2	0	1	0	0	0
#160005 Butte Greeley School	226	109.0	94.7	1.25	9	1	4	4	-	-	-	-	-	-	-	-	-	3	0	1	0	0	0
#160011 City Butte Atkins	130	54.6	37.7	2.89	12	4	4	4	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
#160014 Silver Bow Co. Richer Residence	46	21.8	17.9	1.67	12	4	4	4	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
#160016 Butte Gilman Construction	37	37.0	37.0	1.00	1	-	-	1	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0

Table 3-27 (continued)

* Alert
**Warning
***Emergency

Butte-Anaconda 1977 (continued) SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#1480015 Silver Bow Co. Tierney Residence	64	35.2	31.8	1.21	11	3	4	4	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
MERDI Met. Station	82.77	N/A	14.49	N/A	55	-	4	14	15	16	6	-	-	-	-	-	-	0	0	0	0	0	0

TABLE 3-28

BUTTE-ANACONDA 1971-77 VIOLATIONS OF THE MONTANA AND FEDERAL TOTAL SUSPENDED PARTICULATE STANDARDS

Year	# Stations Operating	# Stations Exceeding Montana Standards			# Stations Exceeding Federal Standards					
					Primary			Secondary		
		Annual Geo. Mean $75\mu g/m^3$	Max 24hr. avg. $200\mu g/m^3$	#Days $>200\mu g/m^3$	Annual $75\mu g/m^3$	24hr 260	#Days >260	Annual $60\mu g/m^3$	24hr. 150	#Days >150
1971	14	6	12	48	6	8	17	7	12	100
1972	14	5	6	14	5	4	7	7	9	35
1973	4	0	2	8	0	1	1	1	3	21
1974	8	2	3	17	2	3	10	3	6	50
1975	13	2	3	18	2	2	11	6	5	40
1976	7	1	4	5	1	2	2	1	5	16
1977	9	1	2	2	1	0	0	2	2	5

may be inaccurate.

In the Whitehall area, an air quality monitoring station was operating during August and September of 1977. Measured levels exceeded TSP standards; however, the short period of record makes the accuracy of the data questionable. Agricultural activity or natural sources, such as forest fires, may be the cause of the high readings. No other data for the area was available.

In summary, both the Butte and Anaconda areas are subject to high levels of TSP in the ambient air. The highest concentrations are measured nearest to the point sources, with particulate levels generally decreasing with distance from the Berkeley Pit or the Anaconda Smelter.

The AQB and MERDI run trace element analyses on the particulates collected by the high volume (Hi-Vol) samplers. Data available includes the following elements:

1. MERDI - Al, Ca, Co, Cd, Cr, Cu, Fe, K, Mn, Ni, Pb, Zn, Na, SO_4, F;
2. AQB - As, Benzene, Cd, F, Pb, SO_4, Zn.

Since similar data was not available for the other CSA's, the data was not included in this report. If future studies require inclusion of trace element measurements, the AQB and MERDI are the sources to contact. Furthermore, the Anaconda Company may also run trace element analyses and would therefore be a third data source.

3.3.1.2 Sulfur dioxide

Sulfur dioxide (SO_2), a gas emitted by numerous point sources in the Butte-Anaconda area, is monitored by the AQB in

the Anaconda region. No SO_2 data is presently available in the Butte valley; however, MERDI will soon begin monitoring the pollutant with an automatic analyzer at the CDIF site.

Tables 3-29 through 3-35 summarize the sulfur dioxide measurements taken in the Anaconda area by the AQB's continuous monitors from 1971-77. Table 3-36 gives the number of violations of the federal and state SO_2 standards in the Anaconda area during the period of record. The table indicates little decrease in SO_2 levels in the ambient air from 1971 to 1977. A large number of violations, especially of 1, 3, and 24-hour averages, are recorded.

The Hiway Junction monitoring station has consistently shown the highest annual averages of SO_2. Maximum 1, 3, and 24-hour averages are recorded at varying stations. In summary, the ambient air in the Anaconda area has levels of SO_2 that often exceed air quality standards. Additional sources of SO_2 will only serve to further degrade the quality of the air.

3.3.1.3 Sulfation rate

Sulfation rate data for the Butte-Anaconda CSA is available from 2 sources: AQB data is available for the Anaconda area for the years 1975-77 (Tables 3-37, 3-38, and 3-39); and data collected in the Butte Valley at MERDI's Met Station is available for 1976 and 1977 (Table 3-40). A number of violations of state standards were recorded during 1975 through 1977 in Anaconda, but the MET station did not report levels exceeding standards in the Butte area. More data is needed before definite conclusions can be drawn about reactive sulfur compounds in the

TABLE 3-29

BUTTE-ANACONDA, ANACONDA 1971 SO_2 CONTINUOUS MONITOR DATA SUMMARY (ppm)

tation	Maximums 1hr.	3hr.	24hr.	Arith. Avg.	#hrs. >0.25	#3hr. per >0.50	#24hr. per. >0.10 ppm	#24hr. per. >0.14 ppm	#24 hr. Alert >0.30	#24 hr. Warning >0.60	#24hr Emergency >0.80	#Days/Mo. sampled J	F	M	A	M	J	J	A	S	O	N	D	Total No. Days Observ.
Baileys Residence	0.45	0.41	0.29	0.02	19	0	1	1	0	0	0	-	-	-	-	-	-	-	-	-	27	-		44
Poor Farm	2.08	1.94	1.33	0.05	75	21	6	4	3	2	2	-	-	-	-	-	-	-	-	31	30	31		92
Warm Springs	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-	5		5

TABLE 3-30

BUTTE-ANACONDA, ANACONDA 1972 SO_2 CONTINUOUS MONITOR DATA SUMMARY (ppm)

tation	Maximums 1hr.	3hr.	24hr.	Arith. Avg.	#hrs. >0.25	#3hr. per. >0.50	#24hr. per. >0.10 ppm	#24hr. per. >0.14 ppm	#24 hr. Alert >0.30	#24 hr. Warning >0.60	#24hr Emergency >0.80	#Days/Mo. sampled J	F	M	A	M	J	J	A	S	O	N	D	Total No. Days Observ.
Warm Springs	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	14	25	-	-	-	-	-	-	-	-	-	-	39
Kucera	0.46	0.31	0.05	0.01	1	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-	4	24	28
Cort-rights	0.35	0.18	0.04	0.01	5	0	0	0	0	0	0	-	-	-	-	-	3	6	21	30	26	21	-	107
Poor Farm	0.45	0.45	0.35	0.01	39	0	3	2	1	0	0	27	28	25	28	31	16	27	2	24	16	6	27	257

TABLE 3-31

BUTTE-ANACONDA, ANACONDA 1973 SO_2 CONTINUOUS MONITOR DATA SUMMARY (ppm)

tation	Maximums 1hr.	3hr.	24hr.	Arith. Avg.	#hrs. >0.25	#3hr. per >0.50	#24hr. per. >0.10 ppm	#24hr. per. >0.14 ppm	#24 hr. Alert >0.30	#24 hr. Warning >0.60	#24hr Emergency >0.80	#Days/Mo. sampled J	F	M	A	M	J	J	A	S	O	N	D	Total No. Days Observ.
Poor Farm	0.53	0.23	0.09	0.01	3	0	0	0	0	0	0	30	-	-	-	-	-	-	-	-	-	-	-	30
Antelope Creek	0.42	0.37	0.07	0.01	9	0	0	0	0	0	0	-	-	-	-	-	-	-	2	20	8	-	-	192
Kucera	0.45	0.30	0.09	0.02	25	0	0	0	0	0	0	15	21	30	26	25	8	-	-	-	-	-	-	125
Post Office	0.52	0.44	0.29	0.05	51	0	7	3	0	0	0	-	-	-	-	-	-	-	-	3	22	29	13	67
Post Office	0.90	0.65	0.15	0.01	32	1	4	0	0	0	0	-	11	20	30	30	30	22	-	-	-	-	-	143
Tailings Pond	0.50	0.50	0.28	0.07	75	1	9	4	0	0	0	-	-	-	-	-	-	-	-	4	31	30	13	78
Tailings Pond	1.70	0.65	0.10	0.01	11	1	1	0	0	0	0	-	-	16	30	31	30	22	-	-	-	-	-	129
Vorteck	0.75	0.65	0.44	0.08	54	3	3	2	1	0	0	-	-	-	-	-	-	-	-	2	10	13	11	36
Vorteck	0.60	0.25	0.07	0.00	4	0	0	0	0	0	0	-	-	13	30	31	30	22	-	-	-	-	-	126
Willow Glenn	0.50	0.30	0.11	0.01	14	0	1	0	0	0	0	-	-	30	27	28	30	31	2	9	21	30	20	228

TABLE 3-32

BUTTE-ANACONDA, ANACONDA 1974 SO_2 CONTINUOUS MONITOR DATA SUMMARY (ppm)

Station	Maximums 1hr.	3hr.	24hr.	Arith. Avg.	#hrs. >0.25	#3hr. per. >0.50	#24hr. per. >0.10 ppm	#24hr. per. >0.14 ppm	#24 hr. Alert >0.30	#24 hr. Warning >0.60	#24hr Emergency >0.80	#Days/Mo. sampled J	F	M	A	M	J	J	A	S	O	N	D	Total No. Days Observ.
Tailings Pond	0.50	0.28	0.04	0.004	5	0	0	0	0	0	0	-	-	-	-	-	-	17	30	29	8	30	31	145
Post Office	0.74	0.55	0.10	0.008	20	3	0	0	0	0	0	-	-	-	-	-	-	15	21	30	31	30	31	158
C-Hill	1.68	1.19	0.30	0.018	32	13	5	2	0	0	0	-	-	-	-	-	-	10	25	30	30	4	-	99
Antelope Creek	0.44	0.31	0.09	0.009	14	0	0	0	0	0	0	-	-	-	-	-	-	12	18	26	27	30	31	144

TABLE 3-33

BUTTE-ANACONDA, ANACONDA 1975 SO_2 CONTINUOUS MONITOR DATA SUMMARY (ppm)

Location	Maximums 1hr.	3hr.	24hr.	Arith. Avg.	#hrs. >0.25	#3hr. per >0.50	#24hr. per. >0.10 ppm	#24hr. per. >0.14 ppm	#24 hr. Alert >0.30	#24 hr. Warning >0.60	#24hr Emergency >0.80	#Days/Mo. sampled J	F	M	A	M	J	J	A	S	O	N	D	Total No. Days Observ.
Hi-Way Jct.	0.75	0.39	0.12	0.014	23	0	2	0	0	0	0	-	-	-	-	-	20	28	31	28	31	30	29	197
C-Hill	1.79	0.86	0.14	0.015	3	3	1	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	13	13
Tailings Pond	0.33	0.29	0.05	0.000	2	0	0	0	0	0	0	31	24	29	30	28	-	-	-	-	-	-	-	142
Pump House	0.35	0.19	0.07	0.005	2	0	0	0	0	0	0	-	-	-	-	-	28	31	31	30	31	30	31	212
Mill Creek RR Cross.	0.83	0.63	0.18	0.012	21	3	2	1	0	0	0	-	-	-	-	-	26	31	27	30	30	29	31	204
Post Office	0.64	0.48	0.12	0.004	17	0	1	0	0	0	0	31	28	31	30	30	30	30	28	30	29	30	31	358

TABLE 3-34

BUTTE-ANACONDA, ANACONDA 1976 SO_2 CONTINUOUS MONITOR DATA SUMMARY (ppm)

Station	Maximums 1hr.	3hr.	24hr.	Arith. Avg.	#hrs. >0.25	#3hr. per >0.50	#24hr. per. >0.10 ppm	#24hr. per. >0.14 ppm	#24 hr. Alert >0.30	#24 hr. Warning >0.60	#24hr Emergency >0.80	#Days/Mo. sampled J	F	M	A	M	J	J	A	S	O	N	D	Total No. Days Observ.
C-Hill	2.54	1.61	0.37	0.016	125	20	15	9	1	0	0	31	29	31	30	30	30	31	23	-	31	27	29	335
Hi-Way Jct.	1.58	1.33	0.60	0.023	180	17	22	9	3	1	0	30	26	31	29	31	30	31	30	30	31	30	31	360
Post Office	1.02	0.68	0.14	0.009	49	2	2	1	0	0	0	31	29	31	12	23	1	1	31	31	29	30	29	6	293
Mill Creek RR Cross.	1.36	0.74	0.16	0.014	59	1	6	1	0	0	0	30	28	27	29	31	30	31	30	27	30	24	9	326
Pump House	0.40	0.21	0.06	0.006	5	0	0	0	0	0	0	31	25	30	27	29	26	8	-	-	-	-	-	176

TABLE 3-35

BUTTE-ANACONDA, ANACONDA 1977 SO_2 CONTINUOUS MONITOR DATA SUMMARY (ppm)

Station	Maximums 1hr.	3hr.	24hr.	Arith. Avg.	#hrs. >0.25	#3hr. per. >0.50	#24hr. per. >0.10 ppm	#24hr. per. >0.14 ppm	#24 hr. Alert >0.30	#24 hr. Warning >0.60	#24hr Emergency >0.80	#Days/Mo. sampled J	F	M	A	M	J	J	A	S	O	N	D	Total No. Days Observ.
C-Hill	1.77	0.71	0.12	0.010	33	1	3	0	0	0	0	31	28	31	27	31	-	-	-	-	-	-	-	148
Hi-Way Jct.	1.46	1.28	0.50	0.029	109	17	13	9	2	0	0	28	28	31	30	31	-	-	-	-	-	-	-	148
Mill Creek	0.88	0.64	0.23	0.019	52	3	5	3	0	0	0	26	28	31	24	28	-	-	-	-	-	-	-	137
Post Office	1.05	0.88	0.16	0.010	34	2	3	1	0	0	0	24	27	31	30	31	-	-	-	-	-	-	-	143

TABLE 3-36

BUTTE-ANACONDA CSA 1971-77 VIOLATIONS OF THE FEDERAL AND MONTANA SULFUR DIOXIDE STANDARDS (ppm)

Year	# Stations Operating	# Stations Exceeding Montana Standards					# Stations Exceeding Federal Standards				
							Primary			Secondary	
		Annual Avg. 0.02 ppm	24hr. avg. 0.10 ppm	1hr. avg. 0.25 ppm	#Days >0.10	#1hr. periods >0.25	Annual Avg. 0.03 ppm	24hr. avg. 0.14 ppm	#Days >0.14	3hour 0.50ppm	#3hr. periods >0.50 ppm
1971	3	1	2	2	7	94	1	2	5	1	21
1972	4	0	1	3	3	45	0	1	2	0	0
1973	7	3	4	7	25	278	3	3	9	3	6
1974	4	0	1	4	5	71	0	1	2	2	16
1975	6	0	4	6	6	68	0	1	1	2	6
1976	5	1	4	5	45	418	0	3	20	4	40
1977	4	1	4	4	24	228	0	3	13	4	23

TABLE 3-37

Sulfation Rate Data

1975 Yearly Summary Anaconda Area

Values in Milligrams Sulfur Trioxide Per 100 Square Centimeters Per Day

Site	Min.	Max.	Aver.	No. Samples	Months Standard Violated	Months Site Operated
Post Office	0.06	0.52	0.244	10	2	Jan.-Nov.
Hiway Jct.	0.13	1.81	0.469	11	2	Jan.-Nov.
Johnson Ranch	0.08	0.34	0.183	10	0	Jan.-Nov.
Anaconda Airport	0.16	0.88	0.321	9	1	Jan.-Sept.
Mill Creek RR	0.14	0.80	0.401	11	2	Jan.-Nov.
Golf Course Exit	0.08	0.28	0.172	11	0	Jan.-Nov.
Wally Johnson Res.	0.11	0.56	0.241	9	1	Jan.-Nov.
Opportunity Main St.	0.04	0.21	0.139	11	0	Jan.-Nov.
Poor Farm	0.02	0.48	0.183	9	0	Jan.-Sep.
Durant Canyon	0.0	0.30	0.118	9	0	Jan.-Sep.
Antelope Creek	0.11	0.40	0.176	5	0	Jan.-May
Pump House	0.06	0.19	0.125	4	0	Jul.-Nov.
A-Hill	0.01	0.15	0.060	3	0	Oct.-Dec.
B-Hill	0.01	0.03	0.020	3	0	Oct.-Dec.
D-Hill	0.0	0.03	0.015	2	0	Oct.-Dec.
E-Hill	0.02	0.04	0.027	3	0	Oct.-Dec.
F-Hill	0.0	0.01	0.003	3	0	Oct.-Dec.

TABLE 3-38

SULFATION RATE DATA

Yearly Summary Anaconda Area - 1976

Values in Milligrams Sulfur Trioxide

Per 100 Square Centimeters per Day

Site	Max.	Annual Aver.	No. Samples	Months Standard Exceeded
Hiway Jct.	2.57	1.01	11	7
Lost Creek	0.24	0.24	6	0
Durant Canyon	0.13	0.11	3	0
A-Hill	0.02	0.01	3	0
B-Hill	0.70	0.34	12	2
C-Hill	1.04	0.67	6	5
D-Hill	1.15	0.54	7	3
E-Hill	1.12	0.47	12	4
F-Hill	0.70	0.25	8	2
G-Hill	1.87	1.16	7	6
H-Hill	0.45	0.28	8	0

Table 3-39

1977 Sulfation Rate Yearly Summary- Butte-Anaconda Area (milligrams $SO_3/100cm^2/day$)

Site	Max.	Annual Average	No. Samples	Months Std. Exceeded	Months Site Operated	
#0400004 Deer Lodge Co. Hwy. 48 Junction	1.600	1.290	2	2	Jan.-Feb.	
#0400802 Deer Lodge Co. B-Hill	0.380	0.215	2	0	Jan.-Feb.	
#0400804 Deer Lodge Co. E-Hill	0.360	0.270	2	0	Jan.-Feb.	
#0400806 Deer Lodge Co. Hill (G)	0.320	0.320	1	0	Jan.	
#0400807 Deer Lodge Co. Hill (H)	0.240	0.240	1	0	Jan.	
#0400906 Deer Lodge Co. C-Hill	0.350	0.290	2	0	Jan.-Feb.	
#0400907 Deer Lodge Co. G-Hill	0.130	0.130	1	0	Feb.	
#0400908 Deer Lodge Co. H-Hill	0.230	0.230	1	0	Feb.	

TABLE 3-40

1976-77 BUTTE (MERDI) YEARLY SULFATION RATE DATA (values in mg $SO_3/100\ cm^2/day$)

Station and Year	Minimum	Maximum	Average	No. Samples	Months Std. Violated	Months Site Operated	
1976 MET (CDIF Site)	0.170	0.333	0.242	5	0	Aug-Dec	Std.- 0.25 mg $SO_3/100cm^2/day$ annual 0.50 mg $SO_3/100cm^2/day$ 1-month
1977 MET (CDIF Site)	0.269	0.424	0.346	5	0	Jan-May	

Butte valley, but enough data is available to indicate a problem with reactive sulfur compounds in the Anaconda area.

3.3.1.4 Dustfall

Dustfall, in tons/sq. mile/month, is recorded at MERDI's Met station in the Butte valley. However, not enough data was present to permit a valid comparison with other areas. The data will be available from MERDI for future studies.

3.3.1.5 Fluorides

Because of a major point source in the Butte-Anaconda CSA, fluorides are present in standards exceeding amounts in much of the Butte area. Tables 3-41 through 3-47 summarize fluoride data for the Ramsay-Silver Bow area for 1975 through 1977. Table 3-41 presents data collected by fluoride tape, whereas Tables 3-42 through 3-47 are derived from Na and Ca Formate paper samples. One station near Anaconda (Durant Canyon) was also monitored for fluorides during 1976 and 1977. Tables 3-42 through 3-47 show consistent violations of the Montana gaseous fluorides standard (0.3 $\mu g/cm^2$/30 days).

Data collected by static air sampling at MERDI's Met station with Calcium (Ca) and Sodium (Na) formate papers is available from August 1976 through May of 1977. Presented in Table 3-48, the fluoride data from the Met station also indicates frequent violations of state standards. These two sets of data indicate substantial fluoride pollution of the Butte-Anaconda CSA, especially in the Ramsay-Butte valley area.

Until a shutdown in late 1975, the Rocky Mountain Phosphate Company plant in Garrison, Montana was a large source of

Table 3-41

BUTTE-ANACONDA 1975 FLUORIDE YEARLY SUMMARY - FLUORIDE TAPE (PPB) 4 Hour Intervals

Station	Arith. Avg.	Maximums 1hr.	3hr.	24hr.	No. 24 hr. periods over 0.50	1.00	1.25	1.50	2.00	2.50	3.00	No. Days Data	No. Days data/mo. J	F	M	A	M	J	J	A	S	O	N	D	Total Readings
Ramsay Area Tierney Res.	0.207	6.29	6.29	3.97	12	2	1	1	1	1	1	149	-	-	-	-	-	-	24	29	29	26	30	11	3423

TABLE 3-42($\mu g/cm^2$/30 days)

BUTTE-ANACONDA AREA (RAMSAY) 1975 YEARLY SUMMARY GASEOUS FLUORIDE DATA - Na FORMATE PAPERS

Station	Max.	Average	No. Samples	Months Std. Violated	Months Site Operated	Remarks
#1480001 Silver Bow Co. Ramsay West	3.21	1.612	12	12	Jan.-Dec.	State Std. - 0.3$\mu g/cm^2$/28 days for Ca Formate
#1480002 Silver Box Co. Ramsay North	1.38	0.651	9	7	Jan.-Dec.	
#1480003 Silver Bow Co. Silver Bow Exit	1.73	1.097	8	8	Jan.-Dec.	
#1480004 Silver Bow Co. ESE of Stauffer	5.11	3.143	12	12	Jan.-Dec.	
#1480005 Silver Bow Co. S. of Stauffer	1.31	1.175	10	10	Jan.-Dec.	
#1480006 Silver Bow Co. S. of Stauffer Ponds	2.20	1.259	8	8	Jan.-Dec.	

TABLE 3-43($\mu g/cm^2$/30 days)

BUTTE-ANACONDA AREA (RAMSAY) 1975 YEARLY SUMMARY GASEOUS FLUORIDE DATA - Ca FORMATE PAPERS

Station	Max.	Average	No. Samples	Months Std. Violated	Months Site Operated	Remarks
#1480001 Silver Bow Co. Ramsay West	2.24	1.338	12	12	Jan.-Dec.	State Std. -0.3$\mu g/cm^2$/28 days for Ca Formate
#1480002 Silver Bow Co. Ramsay North	0.99	0.576	12	9	Jan.-Dec.	
#1480004 Silver Bow Co. ESE of Stauffer	6.89	3.002	11	11	Jan.-Dec.	
#1480005 Silver Bow Co. S. of Stauffer	1.22	0.954	11	11	Jan.-Dec.	
#1480006 Silver Bow Co. S. of Stauffer Pond	2.20	1.385	11	11	Jan.-Dec.	
#1480012 Silver Bow Co. Ponds Edge #1	40.81	8.448	10	6	Jan.-Dec.	
#1480043 Silver Bow Co. Ponds Edge #2	3.98	2.069	11	11	Jan.-Dec.	
#1480016 Silver Bow Co. MT Power Substation	3.55	2.150	7	7	June-Dec.	

TABLE 3-44($\mu g/cm^2$/30 days)

BUTTE-ANACONDA AREA (RAMSAY) 1976 YEARLY SUMMARY GASEOUS FLUORIDE DATA - Na FORMATE PAPERS

Station	Max.	Average	No. Samples	Months Std. Violated	Months Site Operated	Remarks
#1480001 Silver Bow Co. Ramsay West	2.170	1.380	5	5	Jan.-April & June	State Std. - 0.3$\mu g/cm^2$/28 days for Ca Formate
#1480002 Silver Bow Co. Ramsay North	1.000	0.867	3	3	Jan.-Mar.	
#1480004 Silver Bow Co. ESE of Stauffer	10.920	5.290	5	5	Jan.-April & June	
#1480005 Silver Bow Co. S. of Stauffer	1.310	0.953	3	3	Jan., Feb., April	
#1480006 Silver Bow Co. S. of Stauffer Pond	2.200	1.168	5	5	Jan.-April & June	
#0400028 Deer Lodge Co. Durant Canyon	2.290	1.743	3	3	Jan., Feb., April	

TABLE 3-45($\mu g/cm^2$/30 days)

BUTTE-ANACONDA AREA (RAMSAY) 1976 YEARLY SUMMARY GASEOUS FLUORIDE DATA - Ca FORMATE PAPERS

Station	Max.	Average	No. Samples	Months Std. Violated	Months Site Operated	Remarks
#1480001 Silver Bow Co. Ramsay West	1.750	1.170	6	6	Jan.-June	State Std. -0.3$\mu g/cm^2$/28 days for Ca Formate
#1480002 Silver Bow Co. Ramsay	0.910	0.537	6	4	Jan.-June	
#1480004 Silver Bow Co. ESE of Stauffer	7.870	4.508	6	6	Jan.-June	
#1480005 Silver Bow Co. S. of Stauffer	1.610	1.155	6	6	Jan.-June	
#1480006 Silver Bow Co. S. of Stauffer PO	1.990	1.092	6	6	Jan.-June	
#1480012 Silver Bow Co. Ponds Edge #1	0.860	0.447	6	3	Jan.-June	
#1480013 Silver Bow Co. Ponds Edge #2	2.430	1.947	3	3	April-June	
#1480016 Silver Bow Co. MT Power Substation	3.910	2.205	6	6	Jan.-June	

TABLE 3-46 ($\mu g/cm^2$/30 days)

BUTTE-ANACONDA AREA (RAMSAY) 1977 YEARLY SUMMARY GASEOUS FLUORIDE DATA - Na FORMATE PAPERS

Station	Max.	Average	No. Samples	Months Std. Violated	Months Site Operated	Remarks
#1480001 Silver Bow Co. Ramsay West	1.860	1.735	2	2	Jan.-Feb.	State Std. - 0.3 $\mu g/cm^2$/28 days for Ca Formate
#1480002 Silver Bow Co. Ramsay North	1.070	0.950	2	2	Jan.-Feb.	
#1480004 Silver Bow Co. ESE of Stauffer	4.920	4.455	2	2	Jan.-Feb.	
#1480005 Silver Bow Co. S. of Stauffer	1.750	1.470	2	2	Jan.-Feb.	
#1480006 Silver Bow Co. S. of Stauffer Po.	1.310	1.195	2	2	Jan.-Feb.	
#1480900 Silver Bow Co. West of Stauffer	2.180	1.805	2	2	Jan.-Feb.	
#0400028 Deer Lodge Co. Durant Canyon	3.470	3.145	2	2	Jan.-Feb.	

TABLE 3-47 ($\mu g/cm^2$/30 days)

BUTTE-ANACONDA AREA (RAMSAY) 1977 YEARLY SUMMARY GASEOUS FLUORIDE DATA - Ca FORMATE PAPERS

Station	Max.	Average	No. Samples	Months Std. Violated	Months Site Operated	Remarks
#1480001 Silver Bow Co. Ramsay West	1.770	1.750	2	2	Jan.-Feb.	State Std. - 0.3 $\mu g/cm^2$/28 days for Ca Formate
#1480002 Silver Bow Co. Ramsay North	1.030	0.850	2	2	Jan.-Feb.	
#1480004 Silver Bow Co. ESE of Stauffer	4.170	3.610	2	2	Jan.-Feb.	
#1480005 Silver Bow Co. S. of Stauffer	1.500	1.195	2	2	Jan.-Feb.	
#1480006 Silver Bow Co. S. of Stauffer Po	1.500	1.260	2	2	Jan.-Feb.	
#1480016 Silver Bow Co. Mt. Power Sub-station	2.350	2.195	2	2	Jan.-Feb.	
#1480900 Silver Bow Co. Stauf-fer West	2.310	1.790	2	2	Jan.-Feb.	

TABLE 3-48(values in $\mu g/cm^2$/30 days)

BUTTE AREA 1976-77 MERDI SUMMARY - GASEOUS FLUORIDE DATA Na & Ca FORMATE PAPERS

Year & Station	Ca Formate Papers					Na Formate Papers					
	Max.	Avg.	No. samples	No. Months Std. Violated	Months site Operated	Max.	Avg.	No. samples	No. Months Std. Violated	Months site operated	Std.
1976 MET (CDIF site)	0.391	0.296	5	3	Aug-Dec	0.538	0.272	4	N/A	Aug-Dec	0.3 $\mu g/cm^2$/28 days Ca Formate N/A-not applicable
1977 MET (CDIF site)	1.005	0.599	5	3	Jan-May	1.131	0.707	4	N/A	Jan-May	

fluorides and particulates. Jim Gelhaus, AQB (personal communication 1977), expects the plant to reopen in the near future, but not without installing better pollution controls. Monitoring is being continued by the AQB to establish a baseline fluoride level in preparation for future operation of the plant. Since the phosphate plant is currently shutdown, no data is included in this report.

3.3.1.6 Carbon monoxide and nitrogen dioxide

A site monitoring carbon monoxide and nitrogen dioxide was recently installed in Butte. Due to the newness of the AQB station (Alpine West), not enough data was available for inclusion in this report. In the future, enough data should be available to better evaluate these pollutants in the Butte area. No monitoring is done for either CO or NO_2 in the vicinity of Anaconda.

3.3.2 Emission Sources

3.3.2.1 Point sources

In the Butte-Anaconda CSA, several point sources emit large amounts of pollutants into the ambient air. Table 3-49 indicates the amount of sulfur dioxide and particulates that are released from major emission sources in the region.

In the Butte vicinity, the Berkeley Open Pit Mine emits large amounts of particulates, hydrocarbons, sulfur dioxide, and oxides of nitrogen. AQB estimates of particulates alone averaged 6,080 tons per year during 1976 (Gelhaus, 1976). Much of the particulate matter settles over the city and is re-entrained by vehicle traffic on city streets. Other point sources in the area include a tepee burner (Montana Pole), three asphalt hot mix

TABLE 3-49

Butte-Anaconda MAJOR EMISSION SOURCES - 1976 (tons/yr.)

Point Source	Sulfur Dioxide (SO_2)	Particulates	NO_x	HC	CO	F	Remarks
Berkeley Pit Butte	207	6080	NM	NM	NM	NM	NM - not measured
Anaconda Company Smelter Anaconda	321,136	10,306	NM	NM	NM	NM	
Stauffer Chemical Company Silver Bow	208	73	NM	NM	NM	NM	
Rocky Mountain Phosphate * Garrison	—	—	—	—	—	—	* Shut down at end of 1975

Source: Gelhaus, 1977.

plants, and a concentrator and crusher that process the Berkeley ore (Gelhaus, 1976).

The Stauffer Chemical Company plant at Silverbow, Montana is a major source of particulates, sulfur dioxide, and fluorides. Although no estimates of fluoride emissions were available, ambient air monitoring around the plant indicates a significant problem with this pollutant. Furthermore, some of the emissions from the plant are thought to drift into the Butte valley and some drift may occur toward Anaconda. According to Gelhaus (1976), a contingency plan for control of fluorides will be developed and final compliance with all visible and fluoride rules and standards will be achieved by March 1, 1978.

In the vicinity of Anaconda, the largest point source is the Anaconda Company Copper Smelter which, according to AQB measurements, emits approximately 321,000 tons/year of SO_2 and 10,300 tons/year of particulates. Currently the Anaconda Company has variances for particulate emissions from the main stack and from the 90% SO_2 control rule which applies to the smelter (Gray, personal communication, 1977). In order to eventually comply with a 75% SO_2 control interim rule, the Anaconda Company is currently expanding their acid plant from 660 tons/day (tpd) to 990 tpd. Only 39% control of SO_2 emissions from the smelter was achieved with the 660 tpd capacity plant. Future compliance with the 90% control rule is hoped for with the acid plant expansion and better controls. Problems with the definition of the number of processes at the smelter has held up compliance with particulate emission regulations. Since the amount of gases

currently coming through the flue system is exceeding the capacity of the baghouse, 50,000-60,000 standard cubic feet per minute (SCFM) is being bypassed to the main stack; the baghouse is handling the other 200,000-300,000 SCFM (Gray, personal communication, 1977). Until the operation is brought into compliance, the area will be subject to high particulate and SO_2 loadings.

Philipsburg, a small community which lies northwest of Anaconda, had two lumber mills (point sources) until early 1975. Presently, only the Flint Valley Mill is operating and since it is not using a tepee burner, there are no point sources in the area (Gray, personal communication, 1977).

The Rocky Mountain Phosphate Company's plant in Garrison was a major point source of particulates and fluorides until it shutdown in late 1975. If it is reopened, it must again be considered in an emission inventory of the Butte-Anaconda CSA.

3.3.2.2 Non-point sources

Some non-point sources which contribute to the level of air pollution in the Butte-Anaconda CSA include incinerators, motor vehicles, agricultural burning and cultivation, and unpaved roads. As mentioned earlier, the dirty streets in Butte are thought to contribute to the high levels of total suspended particulates. Although the non-point sources are practically negligible when compared to point sources in the area, they still have an effect on the overall air quality.

3.4 Glasgow Air Force Base Candidate Site Area

3.4.1 Baseline Air Quality

The Glasgow candidate site area (CSA) is sparsely populated when compared with the other four CSA's. Because of this low population den-

sity and the lack of industrial development in the area, air quality generally can be considered excellent.

Since the AQB has no ambient air monitoring stations in Glasgow, the closest station had to be chosen and the data extrapolated. The McCone County-Fort Peck station was chosen because of its closeness to Glasgow and because it appears to be in the same "airshed" as the Glasgow-Glasgow Air Force Base region. AQB personnel indicated that the Fort Peck Dam station, which is the only one within or near the Glasgow CSA 40 mile radius, would have levels of air quality representative of the Glasgow area. Total suspended particulate, sulfur dioxide, and nitrogen dioxide are recorded at the Fort Peck monitoring station.

3.4.1.1 Total suspended particulates

Table 3-50 shows the levels of total suspended particulates (TSP) recorded at the Fort Peck station during 1975, 1976, and 1977. As expected, the levels of particulates are generally less than Federal or state standards. One violation of the Federal secondary standard (150 $\mu g/m^3$ - 24 hour average) occurred during 1976; however, this was an isolated case and was probably due to a dust storm or agricultural activity. Although an industrial plant would be allowed to emit substantial amounts of TSP before the standards were exceeded, the effects of increased air pollution on the surrounding environment will need further study.

3.4.1.2 Sulfur dioxide

Sulfur dioxide (SO_2) data (gathered by a gas bubbler) is given in Table 3-51 for the years 1976 and 1977. Since there are no large sources of SO_2 in the area, no SO_2 was detected

Table 3-50

* Alert

***Emergency

GLASGOW-FT. PECK 1975-77 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$) **Warning

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m	260	200	375*	625**	875***
1977																							
#980001 McCone Co. Fort Peck	91	42.6	26.5	1.06	10	1	4	2	2	1	-	-	-	-	-	-	-	0	0	0	0	0	0
1976																							
#980001 McCone Co. Fort Peck	166	30.8	21.1	1.99	35	1	4	3	5	4	1	4	1	4	3	4	1	1	0	0	0	0	0
1975																							
#980001 McCone Co. Fort Peck	26	17.8	15.4	1.73	4	-	-	-	-	-	-	-	-	3	1	-	-	0	0	0	0	0	0

Table 3-51

GLASGOW 1976-77 SUMMARY - SO_2 BUBBLER DATA (ppm)

Station	Max. 24 hr. avg.	Arith. Mean	Geo. Mean	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 0.02	0.05	0.100	0.140	0.200	0.250
1977																						
McCone Co. Fort Peck	0.0000	0.0000	0.0000	13	-	-	3	1	3	-	-	-	-	-	-	-	0	0	0	0	0	0
1976																						
McCone Co. Fort Peck	0.00	0.00	0.00	27	-	3	2	3	4	3	5	1	5	-	-	-	0	0	0	0	0	0

TABLE 3-52

GLASGOW 1975-77 SUMMARY NO_2 BUBBLER DATA (ppm)

Station	Max. 24 hr. avg.	Arith. Mean	Geo. Mean	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 0.025	0.050	0.075	0.00	0.200	0.300
1977																						
McCone Co. Fort Peck	0.000	0.000	0.000	11	-	-	3	2	-	-	-	-	-	-	-	-	0	0	0	0	0	0
1976																						
McCone Co. Fort Peck	0.085	0.0046	0.0002	28	-	4	2	4	4	3	5	0	5	1	-	-	1	1	1	0	0	0
1975																						
McCone Co. Fort Peck	0.0080	0.0050	0.0040	2	-	-	-	-	-	-	-	-	1	1	-	-	0	0	0	0	0	0

during 1976 or 1977 to date.

3.4.1.3 Nitrogen dioxide

Data on levels of nitrogen dioxide (NO_2) detected at the Fort Peck site for 1975-77 are presented in Table 3-52. Again, the levels measured were far below the federal primary annual standard of 0.05 ppm. This substantiates the low population density and lack of industry in the area.

3.4.2 Emission Sources

3.4.2.1 Point sources

The only documented point source in the Glasgow CSA is the Tumpane Company heating plant at the Glasgow Air Force Base (AFB). According to AQB figures (Table 3-53) the boiler (heating plant) emits 174 tons/year of sulfur dioxide and 29 tons/year of particulates. No other point sources are known to be in the Glasgow CSA at this time.

Table 3-53

Glasgow Area Major Emission Sources - 1976 (tons/yr.)		
Point Source	Sulfur Dioxide	Particulates
Tumpane Co. Glasgow AFB	174	29
Source: Gelhaus, 1977.		

3.4.2.2 Non-point sources

Non-point sources of air pollution in the Glasgow CSA would include agricultural sources such as cultivation and burning, transportation, unpaved roads, mining, and natural sources. Since there are no large point emission sources in the Glasgow area, the levels of air pollutants measured at Fort Peck can be assumed to be from non-point sources. Further monitoring will be

necessary to better define the ambient air quality at specific sites.

3.5 Great Falls Candidate Site Area

3.5.1 Baseline Air Quality

Great Falls, the second largest city in Montana, has occasional problems with air pollution. AQB monitoring stations in the area record levels of total suspended particulates, sulfur dioxide, sulfation rate, and dustfall. Monitoring of other pollutants, such as carbon monoxide, has recently been initiated, but not enough data was available for inclusion in this report.

3.5.1.1 Total suspended particulates

Tables 3-54 through 3-59 give a record of total suspended particulate (TSP) levels in the Great Falls area from 1971 through 1977. For easier interpretation, the TSP data has been summarized in Table 3-60 in the form of violations of state and federal TSP standards.

The annual arithmetic average of total suspended particulates for Region 141 (Great Falls Air Quality Control Region) during 1975 was 47.7 micrograms per cubic meter--$\mu g/m^3$--(Gelhaus, 1976, p. 3). Although this level is well within applicable standards, the data summarized in Table 3-60 indicates occasional violations of standards (especially the 24-hour averages). Within the Great Falls area the air quality varies widely; therefore, on site monitoring is needed to better define the air quality at specific sites.

3.5.1.2 Sulfur dioxide

Sulfur dioxide (SO_2) measurements are presented in yearly summaries for 1972-73 and 1974-75 in Tables 3-61 and 3-62

Table 3-54

* Alert

***Emergency

GREAT FALLS 1971-72 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$) **Warning

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
1972																							
#660007 Great Falls Hospital Roof	202	53	44	7	215	18	16	19	18	19	19	14	23	17	15	19	18	1	0	1	0	0	0
#220016 Cascade Co. Farmers Union Oil Company	234	117	105	15	49	-	-	-	5	2	2	4	8	8	7	6	7	9	0	2	0	0	0
#220016 Cascade Co. Farmers Union Oil Company	110	81	78	23	3	3	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
1971																							
#660007 Grt. Falls Hospital Roof	185	55	47	15	92	-	-	-	-	-	-	-	15	22	21	19	15	1	0	0	0	0	0
#220016 Cascade Co. Farmers Union Oil Company	100	75	70	24	6	-	-	-	-	-	-	-	-	-	-	-	6	0	0	0	0	0	0

Table 3-55

* Alert

***Emergency

GREAT FALLS 1973 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$) **Warning

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#660007 Grt. Falls Hospital Roof	174	51	41	6	127	19	14	16	12	13	1	6	10	7	8	10	11	4	0	0	0	0	0
#660009 Grt. Falls Fire Station #1	204	86	72	30	20	-	-	-	-	-	-	-	-	-	8	5	7	1	0	1	0	0	0
#220016 Cascade Co. Farmers Union Oil Company	265	115	107	13	59	5	5	7	5	8	4	7	5	6	7	-	-	12	1	2	0	0	0
#220027 Cascade Co. Belt Building Supply	31	8	6	2	26	-	-	-	-	5	6	10	5	-	-	-	-	0	0	0	0	0	0
#660009 Grt. Falls Fire Station #1	272	124	112	11	12	-	-	4	5	3	-	-	-	-	-	-	-	2	1	1	0	0	0

Table 3-56

* Alert
**Warning
***Emergency

GREAT FALLS 1974 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#220028 Cascade Co. Belt Cr. Ranger Station	28	16.1	15.0	1.18	10	-	-	-	-	-	-	-	-	-	5	2	3	0	0	0	0	0	0
#660007 Grt. Falls Hospital Roof	128	54.8	48.0	1.31	36	-	-	-	-	-	-	-	-	9	10	10	7	0	0	0	0	0	0
#660009 Grt. Falls Fire Station #1	477	128.1	106.9	1.32	26	-	-	-	-	-	-	-	-	6	7	6	7	6	2	2	1	0	0
Great Falls Hospital Roof	150	53	39	38	10	-	-	-	-	-	-	-	-	-	-	-	10	0	0	0	0	0	0
Great Falls Fire Station #1	140	76	51	50	6	-	-	-	-	-	-	-	-	-	-	-	6	0	0	0	0	0	0

Table 3-57

* Alert
**Warning
***Emergency

Great Falls 1975 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#220027 Cascade Co. Belt	75	35.7	27.5	2.05	4	-	-	-	-	-	-	-	-	-	-	-	4	0	0	0	0	0	0
#660007 Great Falls Hosp. Roof	218	33.1	29.8	1.48	94	4	8	9	9	8	9	8	6	9	9	7	8	1	0	1	0	0	0
#660009 Great Falls Fire Sta. #1	310	70.1	59.7	1.38	83	4	6	8	8	8	5	9	7	8	6	6	8	4	1	3	0	0	0
#220028 Cascade Co. Belt Creek Ranger Sta.	49	16.1	14.1	1.18	19	-	3	2	-	5	-	3	5	1	-	-	-	0	0	0	0	0	0

Table 3-58

* Alert
**Warning
***Emergency

Great Falls 1976 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#660007 City Great Falls Hosp. Roof	124	44.7	36.2	1.59	95	4	4	9	8	9	9	8	9	9	8	9	9	0	0	0	0	0	0
#660009 City Great Falls Fire Sta. #1	202	85.0	74.2	1.34	94	4	4	9	7	8	9	9	9	9	8	9	9	7	0	1	0	0	0
#220026 Cascade Co. Cascade Fire Hall	95	34.3	21.0	3.39	4	4	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0

Table 3-59

Great Falls 1977 SUMMARY-TOTAL SUSPENDED PARTICULATE DATA (values in $\mu g/m^3$)

* Alert
**Warning
***Emergency

Station	Maximum	Arith. Avg.	Geo. Mean	Geo. Std. Dev.	No. Observ	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 150µg/m³	260	200	375*	625**	875***
#660007 City Great Falls Hosp. Roof	225	48.0	36.2	1.65	49	9	8	9	8	7	8	-	-	-	-	-	-	1	0	1	0	0	0
#660009 City Great Falls Fire Sta. #1	869	81.8	58.0	1.64	48	8	8	9	5	9	9	-	-	-	-	-	-	4	1	1	1	1	0

TABLE 3-60

GREAT FALLS CSA 1971-77 VIOLATIONS OF THE MONTANA AND FEDERAL TOTAL SUSPENDED PARTICULATE STANDARDS

Year	# Stations Operating	# Stations Exceeding Montana Standards			# Stations Exceeding Federal Standards					
					Primary			Secondary		
		Annual Geo. Mean $75\mu g/m^3$	Max 24hr. avg. $200\mu g/m^3$	#Days $>200\mu g/m^3$	Annual $75\mu g/m^3$	24hr $260\mu g/m^3$	#Days $>260\mu g/m^3$	Annual $60\mu g/m^3$	24hr. $150\mu g/m^3$	#Days $>150\mu g/m^3$
1971	2	0	0	0	0	0	0	1	1	1
1972	2	1	2	3	1	0	0	1	2	10
1973	4	2	2	4	2	2	2	2	3	19
1974	4	1	1	2	1	1	2	1	1	6
1975	4	0	2	4	0	1	1	0	2	5
1976	3	0	1	1	0	0	0	1	1	7
1977	2	0	2	2	0	1	1	0	2	5

respectively. Data obtained during 1972-73 was collected by a continuous monitor (automatic analyzer), whereas the 1974-75 data was collected by a gas bubbler. Table 3-63 shows the number of violations of state and federal standards recorded during the four year period. SO_2 standards were exceeded at two AQB monitoring stations located near the Phillips Oil Refinery during 1972. However, measurements taken in the same area in 1973 showed only a few violations of Montana's 1-hour standard. Moreover, SO_2 bubblers at Fire Station #1 in 1974 and at the Cascade County Health Department in 1975 were unable to detect the gas. SO_2 monitoring has been discontinued since 1975 in the Great Falls area due to the relatively low concentrations of the pollutant. Unlike the Billings and Butte-Anaconda areas, SO_2 does not appear to be a pollution problem in Great Falls.

3.5.1.3 Sulfation rate

Yearly summaries of sulfation rate data recorded in the Great Falls area during 1975 through 1977 are presented in Table 3-64, 3-65, and 3-66. Violations of the state standard (0.50 mg SO_3/100 cm^2/day-monthly) were recorded only in the vicinity of the Phillips Refinery. Data indicates that reactive sulfur generally is not a major air pollution problem in Great Falls.

3.5.1.4 Dustfall

Although comparable data was not available for the other CSA's, dustfall data for Cascade County was summarized in the AQB's 1975 and 1976 Annual Air Quality Summaries; furthermore, 1977 data was available up through August. Tables 3-67, 3-68, and 3-69 show the total dustfall data for monitoring stations in

TABLE 3-61

GREAT FALLS 1972-73 SO_2 CONTINUOUS MONITOR DATA SUMMARY (ppm)

Location	Maximums 1hr.	3hr.	24hr.	Arith. Avg.	#hrs. >0.25	#3hr. per. >0.50	#24hr. per. >0.10 ppm	#24hr. per. >0.14 ppm	#24 hr. Alert >0.30	#24 hr. Warning >0.60	#24hr Emergency >0.80	#Days/Mo. sampled J	F	M	A	M	J	J	A	S	O	N	D	Total No. Days Observ.
1973																								
Phillips Refinery Speedway	0.10	0.01	0.01	0.00	0	0	0	0	0	0	0	8	-	-	-	-	-	-	-	-	-	-	-	8
Phillips Refinery Black Eagle Paving	0.50	0.26	0.10	0.01	4	0	0	0	0	0	0	7	7	21	27	-	-	-	-	-	-	-	-	62
Same as above	0.41	0.26	0.07	0.01	2	0	0	0	0	0	0	-	-	-	-	-	17	-	-	-	-	-	-	17
1972																								
Phillips Refinery Speedway	0.28	0.27	0.20	0.01	6	0	1	1	0	0	0	-	-	-	-	-	-	-	-	-	20	30	31	81
Fleet Wholesale (Phil. Re.)	0.99	0.81	0.42	0.03	102	11	9	7	2	0	0	-	-	-	6	13	25	14	14	30	12	-	-	114

Table 3-62

GREAT FALLS 1974-75 SUMMARY - SO_2 BUBBLER DATA (ppm)

Station 1975	Max. 24 hr. avg.	Arith. Mean	Geo. Mean	No. Observ.	No. Samples/mo. J	F	M	A	M	J	J	A	S	O	N	D	No. Days over 0.02	0.05	0.100	0.140	0.200	0.250
#660007 Great Falls CCHD	0.0000	0.0000	0.0000	36	-	-	6	4	4	4	4	4	4	6	-	-	0	0	0	0	0	0
1974																						
#660009 Great Falls Fire Sta. #1	0.0000	0.0000	0.0000	10	-	-	-	-	-	-	-	-	-	2	4	4	0	0	0	0	0	0

TABLE 3-63

GREAT FALLS CSA 1972-75 VIOLATIONS OF THE FEDERAL AND MONTANA SULFUR DIOXIDE STANDARDS (ppm)

Year	# Stations Operating	# Stations Exceeding Montana Standards					# Stations Exceeding Federal Standards				
							Primary			Secondary	
		Annual Avg. 0.02 ppm	24hr. avg. 0.10 ppm	1hr. avg. 0.25 ppm	#Days >0.10	#1hr. periods >0.25	Annual Avg. 0.03 ppm	24hr. avg. 0.14 ppm	#Days >0.14	3hour 0.50ppm	#3hr. periods >0.50 ppm
1972	2	1	2	2	10	108	0	2	8	1	11
1973	2	0	0	1	0	6	0	0	0	0	0
1974	1	0	0	0	0	0	0	0	0	0	0
1975	1	0	0	0	0	0	0	0	0	0	0

1975 Sulfation Rate Data Yearly Summary Great Falls Area

Values in Milligrams Sulfur Trioxide Per 100 Square Centimeters Per Day

Site	Min.	Max.	Aver.	No. Samples	Months Standard Violated	Months Site Operated
ACM North	0.038	0.287	0.113	10	0	Jan.-Nov.
Treasurelite	0.0	0.098	0.042	11	0	Jan.-Dec.
Stock Car Track	0.022	0.594	0.191	12	1	Jan.-Dec.
ACM East #1	0.003	0.280	0.103	12	0	Jan.-Dec.
Giant Springs	0.020	0.239	0.069	11	0	Jan.-Dec.
Mt. Power Substa.	0.003	0.200	0.080	10	0	Jan.-Dec.
Rainbow	0.0	0.187	0.059	10	0	Jan.-Dec.
Phillips Ref. E	0.022	0.580	0.250	12	2	Jan.-Dec.
Phillips Ref. N #1	0.091	0.588	0.289	12	1	Jan.-Dec.
Phillips Ref. S	0.066	0.401	0.181	10	0	Jan.-Dec.
Phillips Ref. N #2	0.073	0.284	0.149	11	0	Jan.-Dec.
Conoco W	0.012	0.169	0.059	10	0	Jan.-Dec.
Conoco E	0.024	0.153	0.065	12	0	Jan.-Dec.
River Road	0.0	0.117	0.061	8	0	Jan.-Dec.
Fort Shaw	0.006	0.090	0.034	12	0	Jan.-Dec.
Cascade Fire Hall	0.024	0.196	0.072	12	0	Jan.-Dec.
Belt	0.009	0.181	0.052	12	0	Jan.-Dec.
Vaughn	0.008	0.059	0.032	12	0	Jan.-Dec.
Ulm	0.004	0.125	0.040	12	0	Jan.-Dec.
Eden	0.0	0.074	0.014	12	0	Jan.-Dec.
Stockett	0.014	0.123	0.066	12	0	Jan.-Dec.
Sun River	0.0	0.066	0.023	12	0	Jan.-Dec.
Super America	0.006	0.192	0.064	11	0	Jan.-Dec.
Mountain States	0.009	0.202	0.090	11	0	Jan.-Dec.
Fairgrounds	0.0	0.087	0.035	12	0	Jan.-Dec.
Central West	0.0	0.144	0.053	12	0	Jan.-Dec.
J & J Cafe	0.006	0.271	0.091	12	0	Jan.-Dec.
Cascade Co. Health Dept.	0.0	0.085	0.021	10	0	Jan.-Dec.
City Sewage Pump	0.0	0.129	0.067	11	0	Jan.-Dec.
Fire Station #1	0.0	0.084	0.040	11	0	Jan.-Dec.
K-Mart	0.006	0.115	0.042	7	0	Jun.-Dec.
15th St. Br. N.	0.004	0.322	0.114	7	0	Jun.-Dec.
15th St. Br. S.	0.006	0.158	0.055	5	0	Jun.-Dec.
Holiday Village	0.009	0.065	0.041	7	0	Jun.-Dec.

TABLE 3-65

1976 Sulfation Rate Data Yearly Summary Great Falls Area

Values in Milligrams Sulfur Trioxide Per 100 Square Centimeters Per Day

Site	Max.	Annual Aver.	No. Samples	Months Standard Exceeded
ACM North	0.20	0.05	11	0
Treasurelite	0.11	0.03	9	0
Stock Car Track	0.23	0.05	10	0
ACM East #1	0.18	0.04	12	0
Giant Springs	0.11	0.04	12	0
Mt. Power Substa.	0.20	0.06	9	0
Rainbow	0.03	0.01	5	0
Phillips Ref. E.	0.40	0.14	10	0
Phillips Ref. N #1	0.33	0.13	10	0
Phillips Ref. S	0.26	0.08	10	0
Phillips Ref. #2	0.18	0.07	11	0
Conoco W	0.11	0.04	6	0
Conoco E	0.17	0.05	10	0
Fort Shaw	0.10	0.04	11	0
Cascade Fire Hall	0.10	0.06	7	0
Belt	0.16	0.06	10	0
Vaughn	0.07	0.03	10	0
Ulm	0.14	0.05	9	0
Eden	0.08	0.02	12	0
Stockett	0.12	0.06	6	0
Sun River	0.09	0.03	12	0
Super America	0.29	0.08	12	0
Mountain States	0.22	0.07	12	0
Fairgrounds	0.13	0.04	10	0
Central West	0.12	0.05	8	0
J & J Cafe	0.28	0.07	10	0
Casc. Co. Hlth. Dept.	0.08	0.04	12	0
City Sewage Pump	0.17	0.05	8	0
Fire Station #1	0.09	0.03	11	0
K-Mart	0.19	0.09	11	0
15th St. Br. N.	0.12	0.06	11	0
15th St. Br. S.	0.18	0.06	10	0
Holiday Village	0.26	0.09	12	0

Table 3-66

1977 Sulfation Rate Yearly Summary- Great Falls Area (milligrams $SO_3/100cm^2/day$)

Site	Max.	Annual Average	No. Samples	Months Std. Exceeded	Months Site Operated
#0220001 Cascade Co. ACM North	0.242	0.056	7	0	Jan.-Aug.
#0220002 Cascade Co. Treasurelite Plant	0.208	0.050	7	0	Jan.-Aug.
#0220003 Cascade Co. Stock Car Track	0.607	0.248	7	1	Jan.-Aug.
#0220005 Cascade Co. ACM East #1	0.268	0.111	8	0	Jan.-Aug.
#0220009 Cascade Co. Giant Springs Fish Hat.	0.115	0.023	7	0	Jan.-Aug.
#0220010 Cascade Co. Mt. Power Substation	0.223	0.082	8	0	Jan.-Aug.
#0220011 Cascade Co. Rainbow	0.131	0.044	3	0	Jan.-Aug.
#0220012 Cascade Co. Phillips Refinery E.	0.575	0.355	8	2	Jan.-Aug.
#0220013 Cascade Co. Phillips Ref. N1	0.629	0.435	6	1	Jan.-Aug.
#0220015 Cascade Co. Phillips South	0.216	0.127	8	0	Jan.-Aug.

Table 3-66 (continued)

1977 Sulfation Rate Yearly Summary- Great Falls Area (milligrams $SO_3/100cm^2/day$)

Site	Max.	Annual Average	No. Samples	Months Std. Exceeded	Months Site Operated
#0220017 Cascade Co. Phillips N #2	0.263	0.165	7	0	Jan.-Aug.
#0220019 Cascade Co. Conoco West	0.190	0.062	8	0	Jan.-Aug.
#0220020 Cascade Co. Conoco East	0.152	0.057	8	0	Jan.-Aug.
#0220025 Cascade Co. Fort Shaw	0.098	0.016	6	0	Jan.-Aug.
#0220026 Cascade Co. Cascade Firehall	0.201	0.043	6	0	Jan.-Aug.
#0220032 Cascade Co. Vaughn	0.138	0.030	8	0	Jan.-Aug.
#0220033 Cascade Co. Ulm	0.170	0.049	7	0	Jan.-Aug.
#0220034 Cascade Co. Eden	0.167	0.051	6	0	Jan.-Aug.
#0220035 Cascade Co. Stockett	0.152	0.036	8	0	Jan.-Aug.
#0220036 Cascade Co. Sun River	0.196	0.053	7	0	Jan.-Aug.

Table 3-66 (continued)

1977 Sulfation Rate Yearly Summary- Great Falls Area (milligrams SO_3/100cm^2/day)

Site	Max.	Annual Average	No. Samples	Months Std. Exceeded	Months Site Operated	
#0660002 Cascade Co. Super America	0.180	0.080	5	0	Jan.-Aug.	
#0660003 Cascade Co. Mountain States	0.167	0.055	8	0	Jan.-Aug.	
#0660004 Cascade Co. Fairgrounds	0.116	0.038	7	0	Jan.-Aug.	
#0660005 Cascade Co. Central West	0.164	0.056	8	0	Jan.-Aug.	
#0660006 Cascade Co. J&J Cafe	0.226	0.132	8	0	Jan.-Aug.	
#0660007 Cascade Co. Hospital Roof	0.166	0.035	8	0	Jan.-Aug.	
#0660008 Cascade Co. City Sewage Pump	0.152	0.070	7	0	Jan.-Aug.	
#0660009 Cascade Co. Fire Station #1	0.181	0.036	7	0	Jan.-Aug.	
#0660011 Cascade Co. K-Mart	0.160	0.068	8	0	Jan.-Aug.	
#0660012 Cascade Co. 15 St. Bridge N.	0.360	0.244	7	0	Jan.-Aug.	

Table 3-66 (continued)

1977 Sulfation Rate Yearly Summary- Great Falls Area(milligrams SO_3/100cm^2/day)

Site	Max.	Annual Average	No. Samples	Months Std. Exceeded	Months Site Operated	
#0660013 Cascade Co. 15 St. Bridge S.	0.281	0.108	6	0	Mar.-Aug.	
#0660014 Cascade Co. Holiday Village	0.244	0.067	7	0	Jan.-Aug.	
#0660015 Cascade Co. 10th Avenue S.	0.013	0.009	2	0	July-Aug.	

TABLE 3-67

Total Dustfall Data

1975 Yearly Summary Great Falls Area

Values in Tons Per Square Mile

Site	Min.	Max.	Aver.	No. Samples	Times Standard Violated	Months Site Operated
Treasurelite Plt.	3.43	20.33	12.55	11	5	Jan.-Dec.
Giant Springs	1.72	26.09	10.76	12	3	Jan.-Dec.
Belt	2.75	9.91	7.57	11	0	Jan.-Dec.
Eden	3.02	7.04	5.15	11	0	Jan.-Dec.
Mountain States	2.88	68.81	26.84	12	7	Jan.-Dec.
Fairgrounds	1.35	46.98	11.56	11	3	Jan.-Dec.
Cascade Co. Health Dept.	1.40	13.63	7.96	11	0	Jan.-Dec.
Fire Station #1	5.24	31.81	14.05	12	6	Jan.-Dec.

Table 3-68.--Total Dustfall Data 1976 Yearly Summary Great Falls Area
Values in Tons Per Square Mile

Site	Max.	Annual Aver.	No. Samples	Times Standard Exceeded	1975 Aver.	1974 Aver.
Treasurelite Plt.	10.80	3.93	11	0	12.55	15.15
Giant Springs	24.81	11.30	12	2	10.76	16.97
Belt	12.51	6.87	10	0	7.57	10.40
Eden	35.64	7.90	12	1	5.15	9.10
Mountain States	44.05	22.21	11	7	26.84	24.26
Fairgrounds	14.92	8.70	12	0	11.56	12.22
Cascade Co. Hlth. Dept	18.94	7.75	12	1	7.96	7.68
Fire Station #1	37.73	18.86	12	8	14.05	18.45

Table 3-69

Total Dustfall Data 1977 Yearly Summary-Great Falls Area (tons/sq. mile)

Site	Max.	Annual Average	No. Samples	Times Std. Exceeded	Months Site Operated
#0220002 Cascade Co. Treasurelite Plant	5.91	3.00	7	0	Jan.-July
#0220009 Cascade Co. Giant Springs Fish Hot.	14.70	9.23	8	0	Jan.-Aug.
#0220034 Cascade Co. Eden	4.21	3.49	6	0	Jan.-Aug.
#0660003 Cascade Co. Mountain States	48.15	23.69	8	6	Jan.-Aug.
#0660004 Cascade Co. Fairgrounds	31.46	14.69	8	4	Jan.-Aug.
#0660007 Cascade Co. Hospital Roof	15.00	8.60	8	0	Jan.-Aug.
#0660009 Cascade Co. Fire Station #1	23.75	16.71	7	4	Jan.-Aug.

and around Great Falls. Numerous violations were recorded, indicating that settleable particulates are present in high concentrations in parts of Cascade County.

3.5.2 Emission Sources

3.5.2.1 Point sources

As shown in Table 3-70, the major industrial emission sources in Great Falls are the Con-Agra Grain Mill, the General Mills Flour Mill, and the Phillips Petroleum Refinery. The grain and flour mills are sources of only particulates, whereas the Phillips Refinery emits particulates and substantial amounts of sulfur dioxide, nitrogen oxides, hydrocarbons, and carbon monoxide.

Based on the ambient air quality monitoring, these point sources do not appear to be seriously degrading the air quality of the Great Falls area. However, particulate standards are occasionally exceeded; both point and non-point sources probably contribute to this problem.

Table 3-70

Great Falls Area Major Emission Sources - 1976 (tons/yr.)

Point Source	Sulfur Dioxide (SO_2)	Particulates	Nitrogen Oxides (NO_x)	(HC) Hydrocarbons	Carbon Monoxide (CO)
Con-Agra Mill Great Falls	0	70	Neg.	Neg.	Neg.
General Mills Great Falls	0	32	Neg.	0	0
Phillips Petroleum Refinery Great Falls	1807	72	142	1404	10,579

Source: Gelhaus, 1977.

3.5.2.2 Non-point sources

Documented, non-point sources in the Great Falls area contribute an estimated 2600 tons/year of SO_2 and 251,000 tons/year of particulates (Gelhaus, 1977). Similar to the other CSA's, a list would include agricultural activity, transportation-motor vehicles, unpaved roads, incinerators and other man-made and natural sources. Again, on site air quality monitoring will be necessary to define the effect of non-point sources on specific areas.

3.6 Livingston Candidate Site Area

3.6.1 Baseline Air Quality

Livingston, Montana is rumored to be one of the windiest cities in the state. Available wind data (see Meteorology Section) does indicate a substantial amount of wind in the valley; moreover, there are no major point sources of air pollution in the area. These two factors combine in giving the Livingston vicinity an air quality that generally is considered to be excellent. Furthermore, no AQB ambient air quality monitoring stations are present in or near the Livingston area, mainly because of the lack of an air pollution problem.

For the purposes of this report, the air quality in the Livingston CSA can generally be considered good; however, ambient air quality monitoring is needed to document this assumption. More study is definitely needed before a decision based on air quality can be made.

3.6.2 Emission Sources

3.6.2.1 Point sources

As shown in Table 3-71, the only point source documented by the AQB in the Livingston area is Burkland Studs in Livingston. According to the state's estimates, the lumber mill emits 1 ton/year

of sulfur dioxide and 12 tons/year of particulates. Another point source, not recognized by the AQB, is the railroad repair-yards; the emissions from the yards are unknown. The presence of other point sources in the area was unknown at the time of this report.

Table 3-71

Livingston CSA - Major Emission Sources -1976 (tons/yr.)		
Point Source	SO_2	Particulates
Burkland Studs Livingston	1	12
Source: Gelhaus, 1977.		

3.6.2.2 Non-point sources

Non-point sources in the Livingston area would likely include agricultural activities, logging slash burning, motor vehicles, unpaved roads, and natural sources (dust storms, hydrocarbon emissions from trees, etc.). The effect of non-point sources on the air quality of the CSA is unknown, but probably negligible. Again, ambient air quality monitoring is needed to better define the air quality of the CSA and of specific sites within it.

3.7 Federal Prevention of Significant Deterioration Regulations

Federal air quality legislation defines "significant deterioration" in all clean air areas as the addition of a specified amount of airborne pollutants. Significant deterioration regulations were initiated to prevent degradation of the air quality in clean air areas, where the existing ambient air quality is cleaner than federal secondary standards (or primary standards if they are more stringent).

To better define these regulations, areas are broken down into 3 classes (Table 3-72). These classes (I, II, and III) are each defined in terms of allowable increases of air pollutants over baseline levels; however, all three classes are limited by federal ambient air quality standards which cannot be exceeded. Furthermore, emission sources in Class II areas that are near Class I areas are subject to Class II mod. (modifications) as shown in Table 3-72. If a facility in a Class II area violates regulations in a nearby Class I area, it may be granted a variance with the concurrence of the Governor and the federal land manager. This variance (Table 3-72), which is defined in terms of allowable increases of SO_2 for both low terrain (less than 900 feet above stack height), and high terrain (> 900 feet above stack height), can be granted for up to 18 days per year (Gelhaus, personal communication, 1977). Currently, only sulfur dioxide and particulates are regulated; however, the Environmental Protection Agency (EPA) is studying the establishment of increments for other pollutants such as nitrogen oxides and hydrocarbons.

The purpose of the significant deterioration regulations is to establish: 1) a uniform national standard against which deterioration of air quality is judged; 2) a national requirement that each new major facility to be located in a clean air area install the best available control technology; and 3) a national interest in the protection of air quality-related values in national parks and wilderness areas.

Class I areas include all international parks without regard to size, and all national memorial parks, national parks, and national wilderness areas in excess of 5000 acres (Clean Air Amendments of 1976). Other valuable resource areas, such as national monuments, national recreation areas, and Indian reservations may be designated Class I if conditions warrant. Other clean air areas where levels of air pollutants are less than federal ambient air quality standards are designated Class II or Class III by the EPA.

Table 3-72

Federal Prevention of Significant Deterioration

August 7, 1977

Increments - (μg/m**3)

	CLASS I	II	III	Not to exceed
TSP-Annual Geo.	5	19	37	75
- 24-Hour	10	37	75	150
SO_2-Annual Arith.	2	20	40	80
- 24-Hour	5	91	182	365
- 3-Hour	25	512	700	1300

Class II mod. (Plants near Class I areas)

TSP - Annual	19
- 24-Hour	37
SO_2-Annual	20
- 24-Hour	91
- 3-Hour	325

Variance (Gov. & Fed. Land Manager) 18 days/year

SO_2	Low Terrain	High Terrain (900 ft. a stack)
- 24-Hour	36	62
- 3-Hour	130	221

In Montana, designated Class I areas include Yellowstone and Glacier National Parks, the Glacier-Waterton International Peace Park, and the wilderness areas (Bob Marshall, Anaconda-Pintler, Selway-Bitterroot, Cabinet Mountains, Lincoln-Scapegoat, and Gates of the Mountains). Furthermore, the Northern Cheyenne Indian Reservation in southeastern Montana was recently designated Class I by the EPA. The rest of the state has received a Class II designation. No Class III areas have been designated in Montana.

Since only small increases in air pollutant levels are allowed in a Class I area, extensive meteorological dispersion studies will be necessary for potential sites on or adjacent to Class I areas. Furthermore, the potential for reclassification of Class II areas to Class I areas should be considered. For example, reclassification of the Fort Peck and Crow Indian Reservations would affect siting possibilities in the Glasgow and Billings areas. In the rest of the state, Class II regulations must be met before siting is initiated.

3.8 Conclusion

Although this report gives an indication of the baseline air quality in some of the CSA's, additional information will be needed if air quality is to be a factor in a siting decision.

In order to present the situation in a concise form, an ambient air quality matrix was developed (Table 3-73). Air pollutants were related to each CSA by recording whether they were exceeding or not exceeding air quality standards. As shown in the matrix, monitoring for nearly all of the air pollutants is conducted in the Billings area. Furthermore, the Butte-Anaconda area does have or will have data for all pollutants except hydrocarbons and ozone. Monitoring in the Great Falls area does not cover NO_2, HC, ozone, or fluorides, and SO_2 monitoring has recently been discontinued. Within

Table 3-73- AMBIENT AIR QUALITY MATRIX

Candidate Site Areas	Air Pollutants: Total Suspended Particulates (TSP)	Sulfur Dioxide (SO_2)	Sulfation Rate	Nitrogen Dioxide (NO_2)	Carbon Monoxide (CO)	Hydrocarbons (HC)	Ozone (O_3)	Fluorides	Dustfall (Settleable Particulates)	Remarks
Billings	e	e	e	ne	e	NC	e	NM	NM	
Butte-Anaconda	e	e	e	NM[c]	NM[c]	NM	NM	e	NM[d]	[c] monitoring just initiated [d] not enough data available
Glasgow	ne[b]	ne	NM	ne	NM	NM	NM	NM	NM	[b] only one isolated, violation was recorded
Great Falls	e	ne[e]	ne[a]	NM	NM[d]	NM	NM	NM	e	[a] exceeded only around oil refinery
Livingston	NM	NM	NM	NM	NM	NM	NM	NM	NM	[e] monitoring stopped in 1975

e - exceeding Montana or federal ambient air quality standards
ne - not exceeding standards
NM - not monitored for
NC - not comparable with standards

the Glasgow CSA (Fort Peck Station), TSP, SO_2, and NO_2 are monitored; in addition, MERDI will soon begin monitoring for TSP, dustfall, trace elements, and sulfation and nitration rates at Glasgow Air Force Base. No ambient air quality data is gathered in the Livingston CSA.

Therefore, more ambient air quality monitoring is needed, especially in the Glasgow, Great Falls, and Livingston areas. In addition, air quality data is needed for outlying areas, since most of the available data is only for metropolitan areas. Because the AQB is unlikely to increase the size of its monitoring network, MERDI will probably have to monitor the areas where ambient air quality data is lacking.

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Appendix I

Federal Ambient Air Quality Standards

Pollutant	Primary (ug/m^3)	Primary (ppm)	Secondary (ug/m^3)	Secondary (ppm)	Averaging Time
Particulates	75	---	60	---	Annual
	260*	---	150*	---	24-Hour
Sulfur Dioxide	80	0.03	---	---	Annual
	365*	0.14	---	---	24-Hour
	---	---	1,300*	0.5	3-Hour
Carbon Monoxide	10,000*	9.0	---	---	8-Hour
	40,000*	35.0	---	---	1-Hour
Photochemical Oxidants	160*	0.08	---	---	1-Hour
Hydrocarbons	160*	0.24	---	---	3-Hour (6-9 a.m.)
Nitrogen Oxides	100	0.05	---	---	Annual

*Not to be exceeded more than once/year

Appendix I (continued)

Montana Ambient Air Quality Standard

Pollutant	Standard	Averaging Time
Suspended Particulates	75 ug/m^3	Annual
	200* ug/m^3	24-Hour
Sulfur Dioxide	0.02 ppm	Annual
	0.10+ ppm	24-Hour
	0.25[a] ppm	1-Hour
Settled Particulates	15 T/mi^2 (residential area)	3-Month
	30 T/mi^2 (industrial area)	3-Month
Suspended Sulfates	4 ug/m^3	Annual
	12[b] ug/m^3	--
Reactive Sulfur	0.25 mg SO_3/ 100 cm^2/day	Annual
	0.50 mg SO_3/ 100 cm^2/day	1-Month
Fluorides, Total in air (as HG)	1 ppb	24-Hour
Fluorides (Gaseous)	0.3 ug/cm^2/28 days	28-Days

[a]Not to be exceeded for more than one hour in any four consecutive days.

[b]Not to be exceeded more than one percent of the time.

*Not to be exceeded more than one percent of the days in a year.

+Not to be exceeded more than one percent of the days in a 3-month period.

4.0 AIR POLLUTION METEOROLOGY OF FIVE MONTANA CANDIDATE SITE AREAS

4.1 Introduction

Only meteorological parameters pertaining to air pollution will be discussed in this report; climatological data such as temperature, precipitation, relative humidity, and evaporation are covered elsewhere. This introduction explains the parameters covered, and mentions the type of data available for each parameter; each CSA is treated in subsequent sections. Topics covered include wind speed and direction, fog occurrences, and air pollution potential.

Wind speed and direction data were available for most of the candidate site areas (CSA's). Wind roses were compiled for all the CSA's, with the exception of Livingston. Furthermore, record high winds and annual mean speeds were available for weather stations in all five areas. It must be remembered, however, that wind speed and direction data mentioned in this report are collected at Weather Bureau and Flight Service Stations only; therefore, it likely will not apply to the full 40-mile radius of the CSA's.

Although records are kept for both fog and icing conditions at National Weather Service (NWS) stations, only heavy fog data are summarized in the National Oceanic and Atmospheric Administration (NOAA) Local Climatological Data. Occurrences of hoar frost and rime icing are available in NWS records (see remarks section); however, a considerable amount of time would be needed to reduce the data to a usable form. Therefore, icing conditions will not be considered in this report. Data on the number of days of heavy fog (visibility less than ¼ mile) per year was available for all the areas except Livingston.

The potential for air pollution in an area is related directly to the ability of the atmosphere to dilute and disperse pollutants. A number of meteorological parameters, such as diffusion capacity, wind speed and

direction, and mixing depth, affect atmospheric stability. Although it may be calculated when the necessary parameters are measured, no diffusion capacity information was available for any of the CSA's. "Star" (stability array) studies (NOAA), which define wind speed and direction by stability class, are available for Billings, Butte, Glasgow, and Great Falls, but time and expense limitations made it impossible to include "Star" studies in this report.

However, using data from "Star" studies, Doty, et al. (1976) developed maps showing the annual percent frequency of unstable, neutral, and stable categories for cities of the U.S. These three categories are defined by Doty, et al., as follows:

- Instability usually occurs with high positive net radiation and low wind speed;
- Stability usually occurs with negative net radiation and light winds; and
- Neutral conditions are produced by cloudy skies and/or high wind speeds.

Stable conditions tend to be conducive to the buildup of air pollutants, whereas neutral and unstable conditions tend to disperse air pollutants quickly. Figures 4-1, 4-2, and 4-3 show the annual percent frequency of the unstable category, the neutral category, and the stable category, respectively. The numbering system used in the figures is explained in the key given in Figure 4-4.

Tabulations I, II, and III, which cover the frequency of occurrence-average wind speed through the mixing depth for "NOP" (non-precipitation) cases, the frequency of episodes, and the daily mixing depth and average wind speed, are available from the NOAA National Climatic Center (NCC) in Asheville, North Carolina. These tabulations are available for the Glasgow and Great

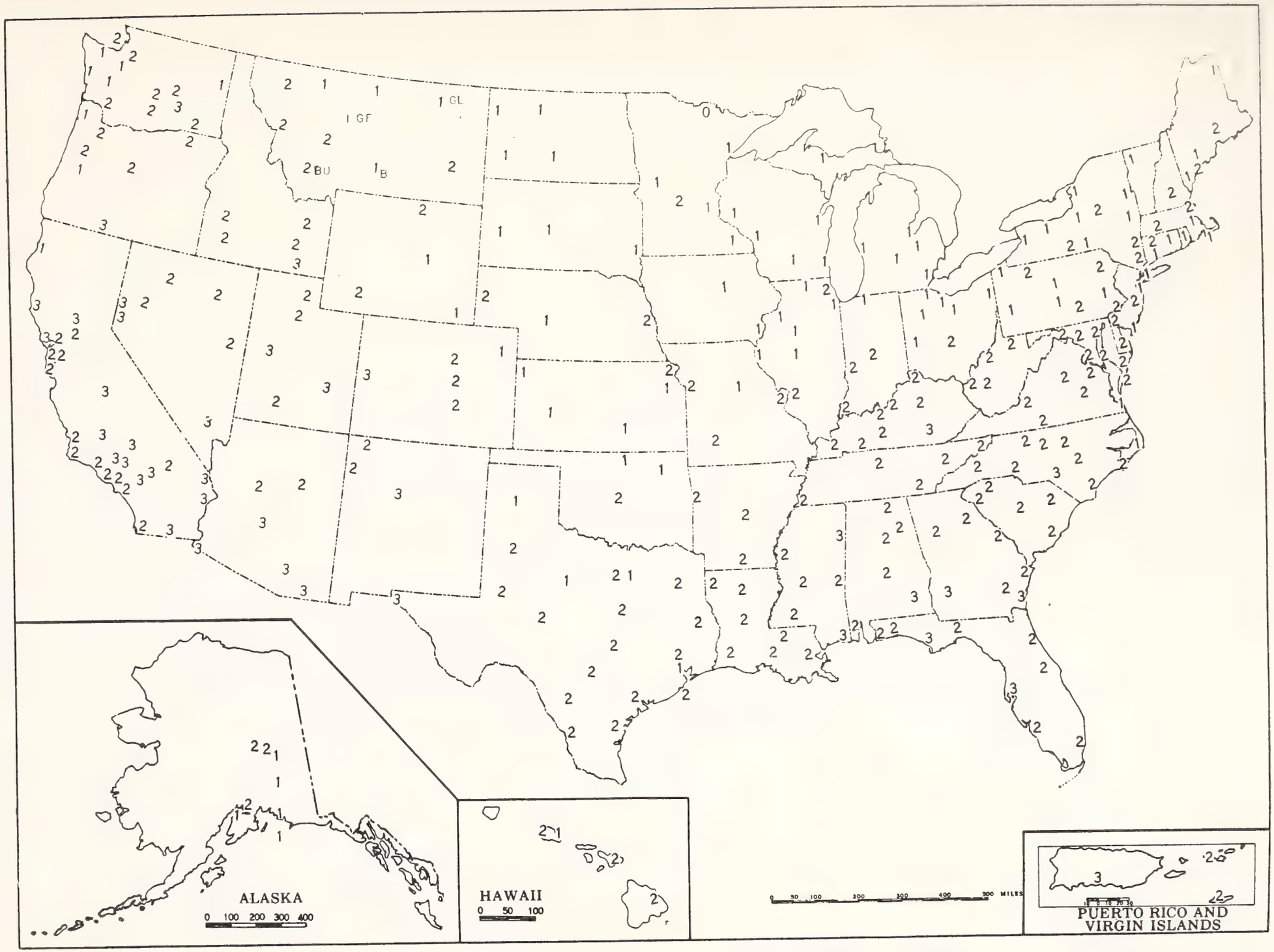


Figure 4-1.--Percent Frequency - Unstable category - Annual

Source: Doty et.al., 1976.

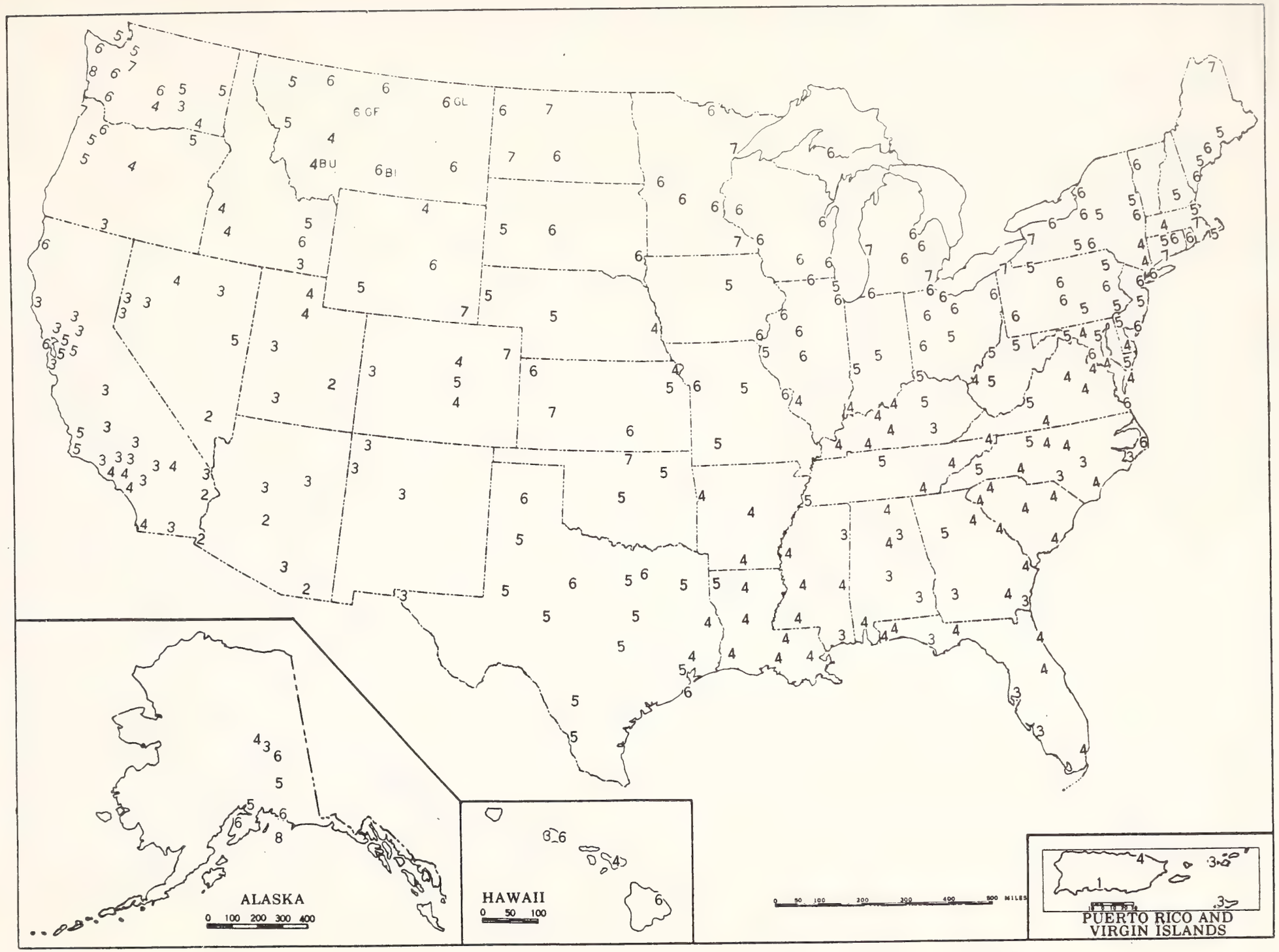


Figure 4-2.--Percent Frequency - Neutral Category - Annual

Source: Doty et. al., 1976

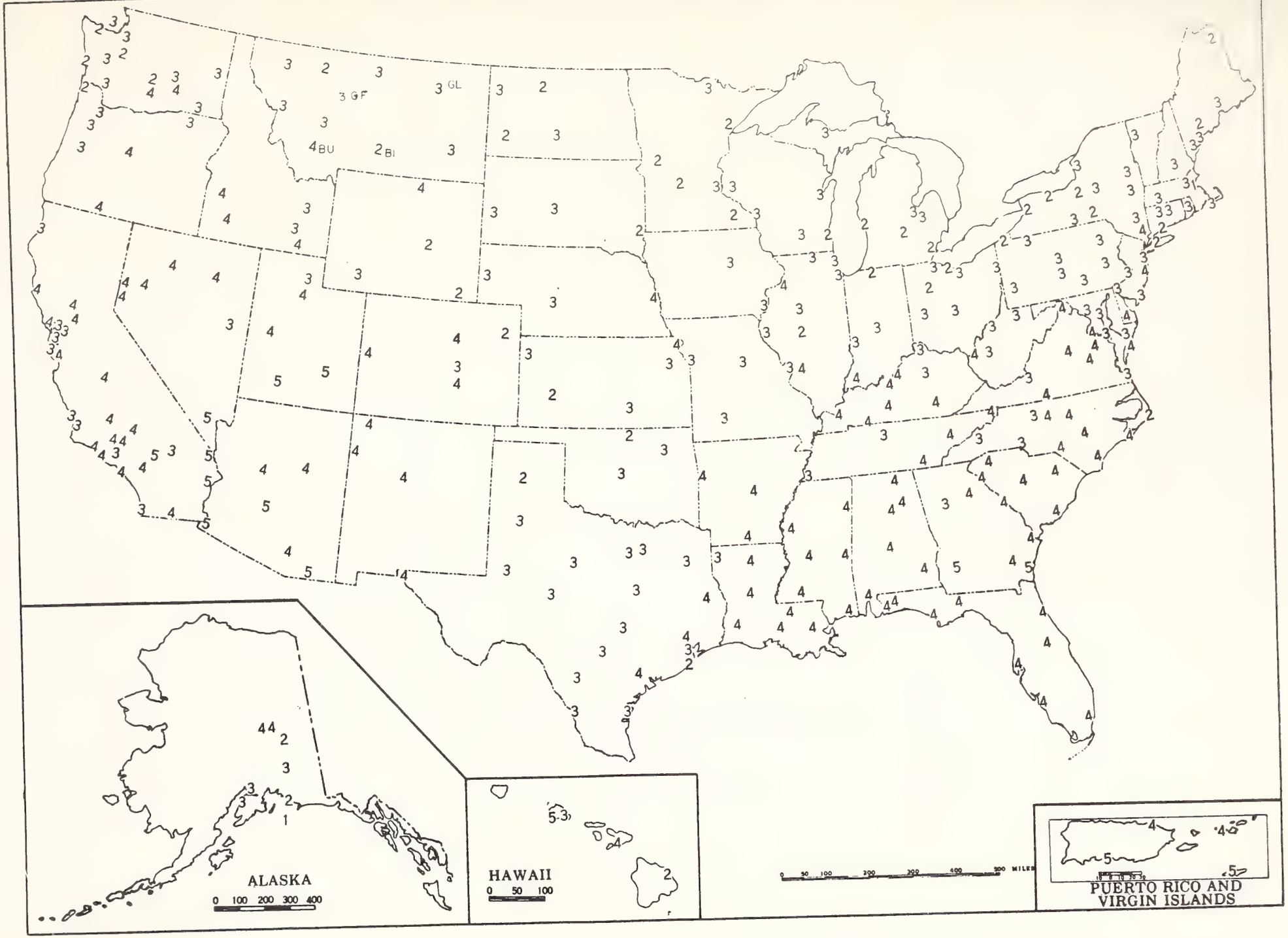


Figure 4-3.--Percent Frequency - Stable Category - Annual

Source: Doty et. al., 1976

Figure 4-4

KEY FOR FIGURES 4-1 TO 4-3

CODE VALUE	RANGE OF PERCENT FREQUENCY
0	0 - 5
1	6 - 15
2	16 - 25
3	26 - 35
4	36 - 45
5	46 - 55
6	56 - 65
7	66 - 75
8	76 - 85
9	86 - 95
10	96 - 100

Source: Doty, et al., 1976.

Falls areas; however, they were not presented in this report because of a lack of data summarization and time limitations.

Inversion studies, which present inversions as a percent frequency of temperature, relative humidity, and wind, have been conducted at Glasgow and Great Falls by the NOAA-Environmental Data Service, NCC. Because of the lack of comparable data for other sites and because of the questionable use of the data in its present form, these studies were not analyzed in this report. They are available from the NCC, Asheville, North Carolina, if they are deemed necessary in the future. More general studies, including Holzworth's Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States and Hosler's Low Level Inversion Frequency in the Contiguous United States, proved more useful for this report.

This report on the air pollution meteorology of the five CSA's cannot be considered complete; it merely presents the baseline data that was available and usable at the time of its writing. Gaps in the baseline data will be noted, and the need for future study will be stressed.

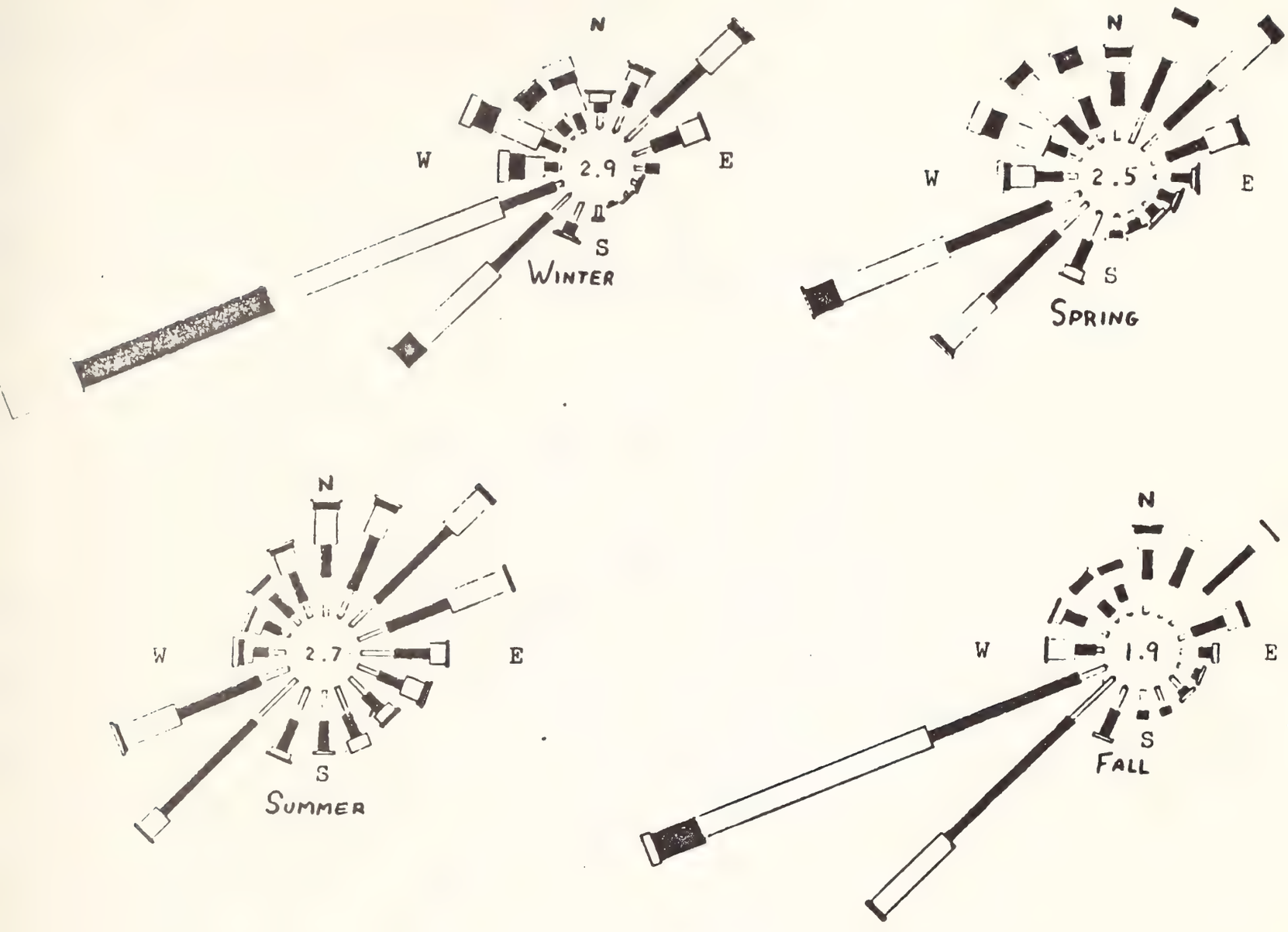
4.2 Billings Area

4.2.1 Wind Speed and Direction

Figures 4-5 and 4-6 are wind roses prepared by the U.S. Public Health Service and the U.S. Air Force Air Weather Service, respectively. An annual wind rose and seasonal wind roses for Billings during 1963 are shown in Figure 4-5. Figure 4-6 was developed from data compiled by the U.S. Air Force for the period 1953 through 1962. Both figures indicate that the prevailing winds are from the southwest, whereas northeast winds have the second highest frequency. Annually, calm conditions occurred approximately 2.5 percent of the time.

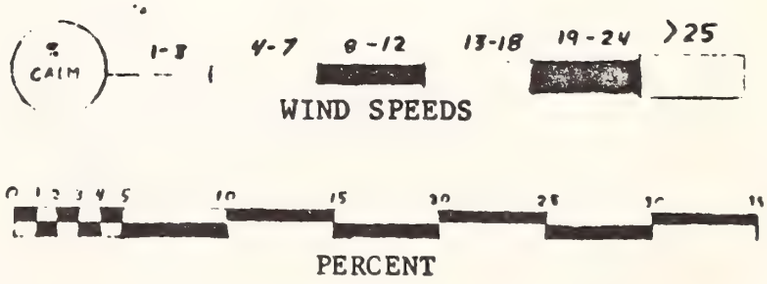
A tabulation by the Weather Bureau showed that the winds were less

Figure 4-5



ANNUAL WINDROSE, BILLINGS, MONTANA

Length of bar equals percent of time wind blows from a given direction - percent calms in center.



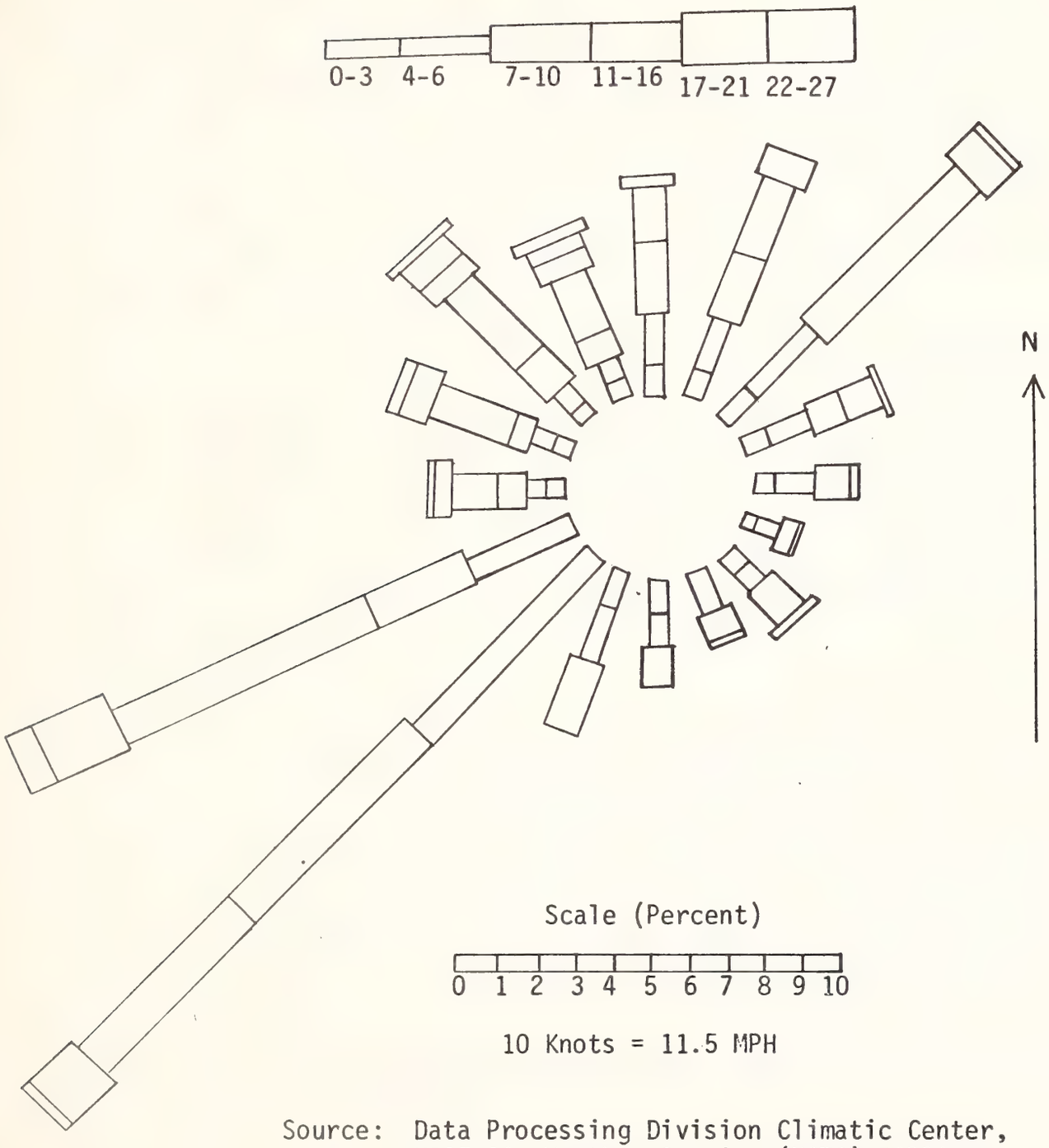
Source: Montana State Department of Health, 1967

BILLINGS, MONTANA
1963

Figure 4-6.--Wind Rose

Billings, Montana

Speed Classes (knots)



Source: Data Processing Division Climatic Center, USAF Air Weather Service (NATS) Billings, Montana NWS 1953 through 1962.

than 7 miles per hour (mph) approximately 25 percent of the time during the 1966-1967 study period (Montana State Department of Health, 1967, p. 7). Furthermore, if 7 mph was included in the tabulation, the percentage would be about 35 percent. Factors further complicating the wind pattern are the 500-foot high bluffs which lie southeast of the city. Since the bluffs run north and south, easterly winds sweeping over the outcrops tend to produce a downwash effect, sweeping pollutants to ground level and reducing the effective height of stacks (Montana State Department of Health, 1967, p. 7).

Table 4-1 presents selected wind data for the five ETF candidate site areas. Billings, with a record high wind of 79 mph and an annual mean speed of 11.5 mph, has the median wind speeds of the 5 CSA's. As shown in Table 4-1, Billings has the highest percentage of time in the 8 to 23 mph range, and it also has the lowest percentage of winds (greater than) 23 mph.

4.2.2 Fog Occurrences

Table 4-2 records heavy fog occurrence in four of the five CSA's; no data was available for Livingston. Heavy fog is defined by NOAA as reducing the visibility to less than ¼-mile. According to NOAA Local Climatological Data, Billings has an average of 18 days of heavy fog per year, with the largest number of foggy days occurring in the fall, winter, and early spring. The other three stations recorded fewer occurrences of heavy fog.

4.2.3 Air Pollution Potential

Billings, lying east of the mountains, has a predominance of neutral conditions and low amounts of stability and instability. Because of the relatively flat nature of the Eastern Montana plains and the

TABLE 4-1

Wind Data for ETF Candidate Sites

Station	Record High (Wind (mph)	Annual Mean (Speed (mph)	Most Freq. Speed (mph)	% Time in Range mph 0-7	8-23	>23	Prevailing Wind Direction	Remarks
Glasgow	46	11.0	9.3	30.5	66.4	3.1	NW	
Living-ston	88	14.1	11.6	23.4	64.5	12.1	SW	
Great Falls	82	12.4	10.4	25.6	67.1	7.3	SW	
Billings	79	11.5	9.3	22.7	75.0	2.3	SW	
Butte	40**	7.9	N/A	N/A	N/A	N/A	NW (S-Night)	** - only 1 year of record N/A - not available

Sources: Obermeir, 1976, NOAA Local Climatological Data, Garrett, 1977.

TABLE 4-2

Fog Occurrences for the Five CSA's

N.W.S. Station (CSA)	Yrs. of Record	Mean # Days/Yr. Heavy Fog (Visibility ≤ ¼mi.)	Mean # Days/Month Heavy Fog - (visibility ≤ ¼ Mile) Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Remarks
Billings	29	18	1	2	2	3	1	1	*	*	1	2	2	2	
Butte	5	6	*	2	1	*	*	0	*	0	*	*	1	1	
Glasgow	17	12	1	2	2	1	*	*	*	*	*	1	2	3	
Great Falls	37	13	1	1	2	2	1	1	*	*	1	1	2	1	* Less than ½ Day
Livingston	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A - not available

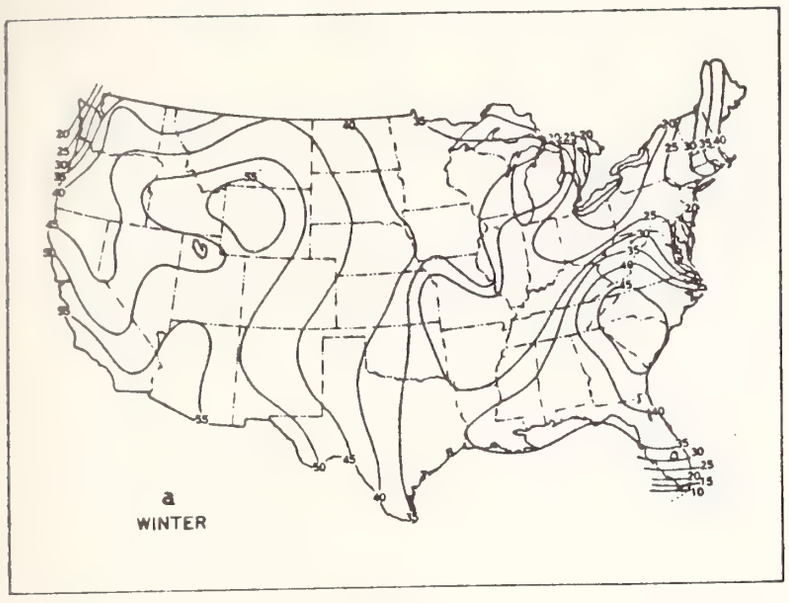
Source: NOAA Local Climatological Data

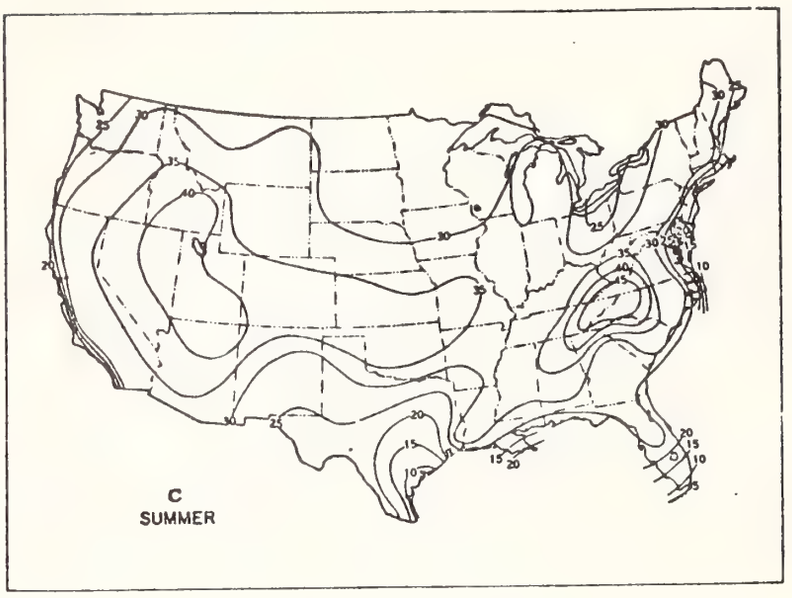
amount of wind, areas east of the Rockies are noted for their lack of stable meteorological conditions.

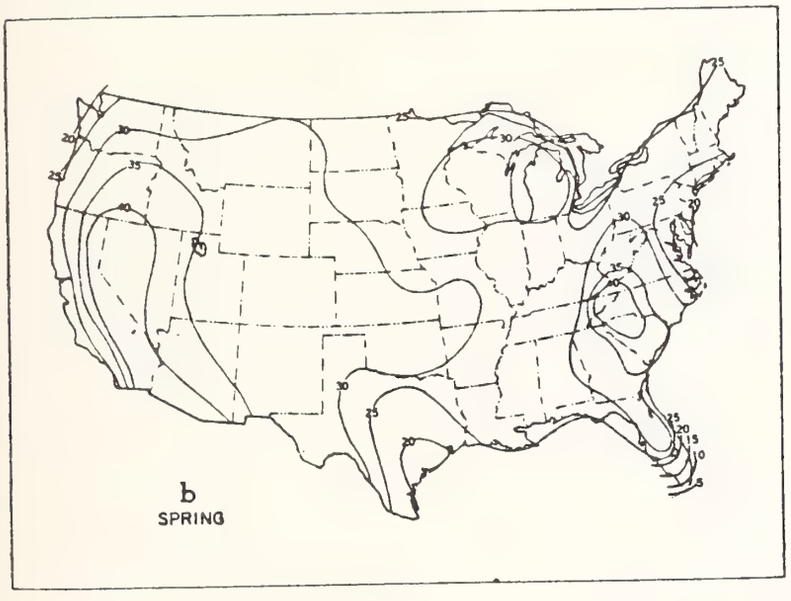
Despite the amount of neutrality indicated above, Billings experiences a moderately high frequency of nocturnal inversions, which usually break up before 10:00 a.m. the following day. Figure 4-7, which gives the inversion frequency as a percent of total hours, suggests that inversions annually occur 40 to 45 percent of the time. This value increases to 50 to 55 percent during the winter and decreases to 30 to 35 percent during the summer. Figure 4-8 shows isopleths of the average nighttime percent cloud cover $\leq$ 3/10 plus the percent wind speed $\leq$ 7 mph, and Figure 4-9 shows the percent frequency of nighttime wind speed $\leq$ 7 mph. These factors, which favor the formation of inversions, are lower in Billings than in western Montana valleys. Figure 4-10 (Holzworth, 1972) shows isopleths of the total number of forecast-days of high meteorological potential for air pollution in a 5-year period. Based on this figure, Billings should experience between 0 and 10 days of high meteorological potential for air pollution in a 5-year period.

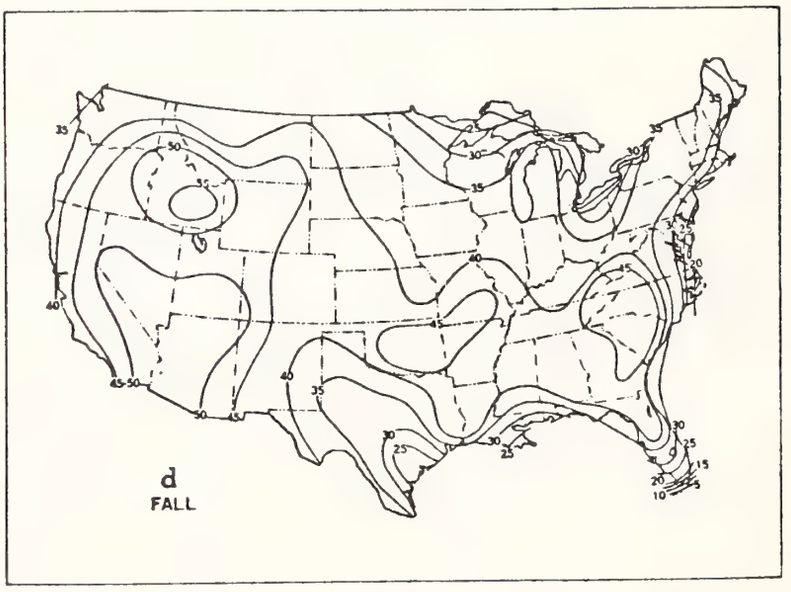
Since Figures 4-1 through 4-3 and 4-7 through 4-10 are extremely broad (covering the entire U.S.) and since they probably are not detailed enough to take into account the effect of topography (valleys, mountains, etc.), only generalizations can be drawn from them. The figures do indicate that the eastern Montana plains generally have a lower potential for air pollution than the western Montana valleys. Further study is definitely needed to better define the air pollution potential of specific sites.

4.3 Butte-Anaconda Area









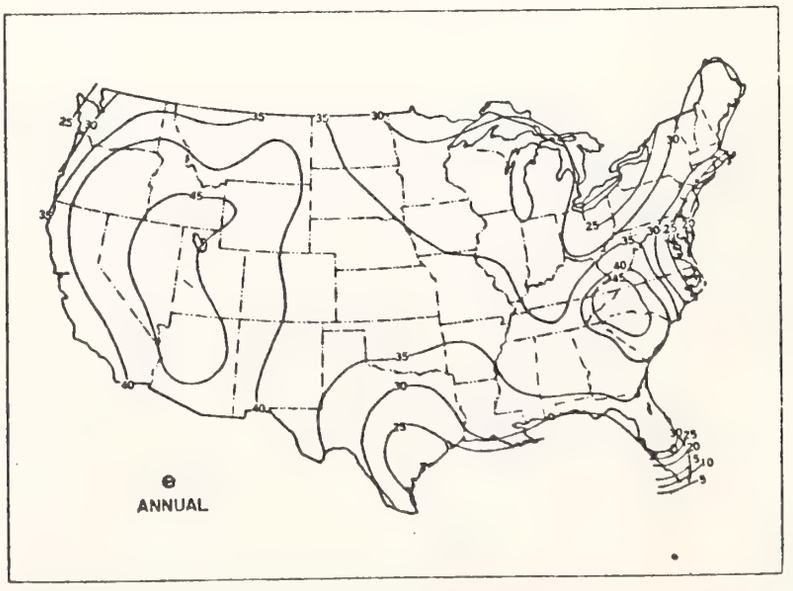
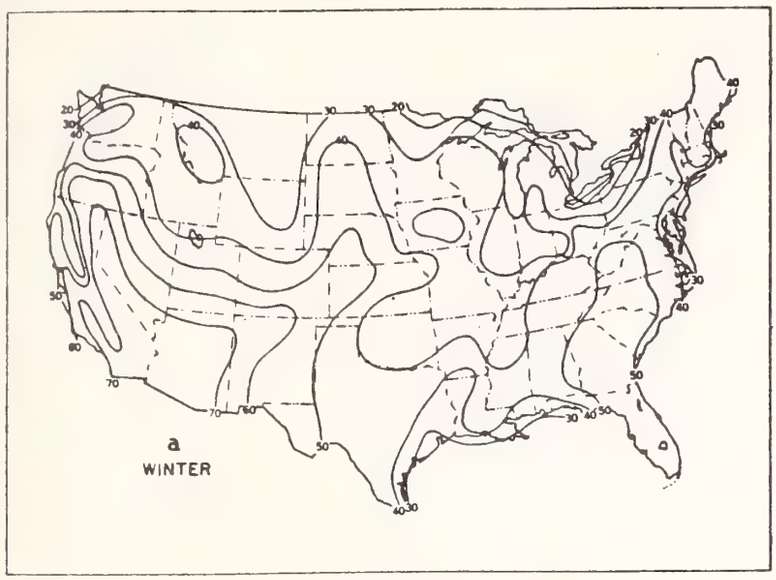
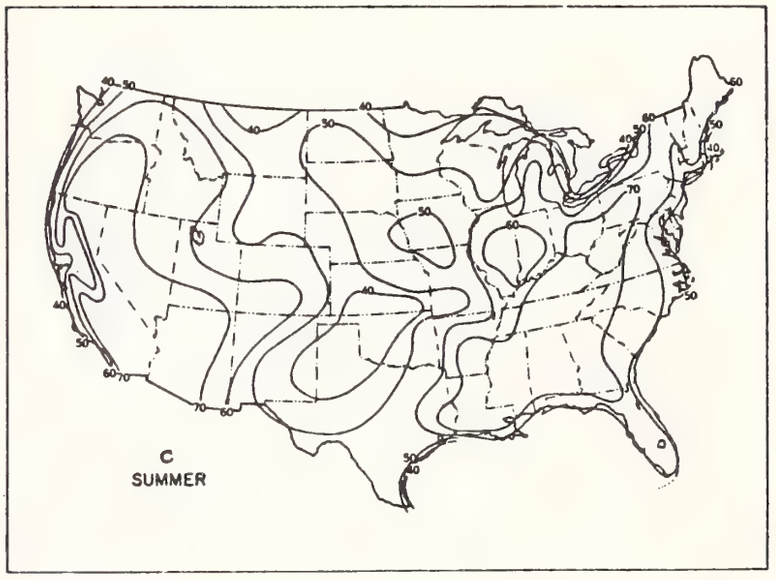
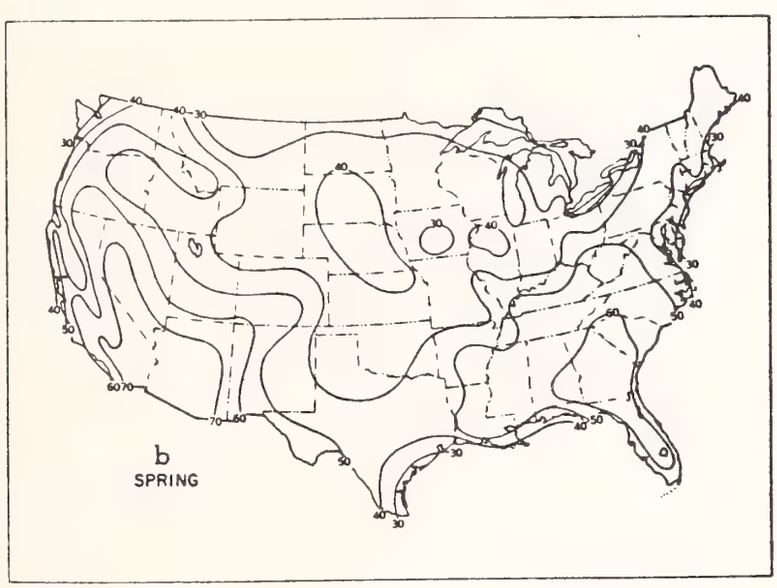


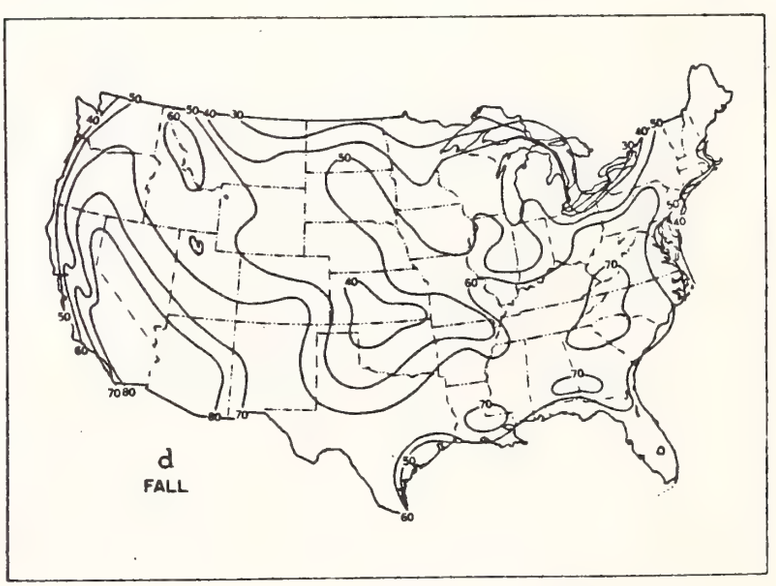
Figure 4-7.--Inversion frequency (percent of total hours): (A) Winter, (B) Spring, (C) Summer, (D) Fall, (E) Annual.

Source: Hosler, 1961.









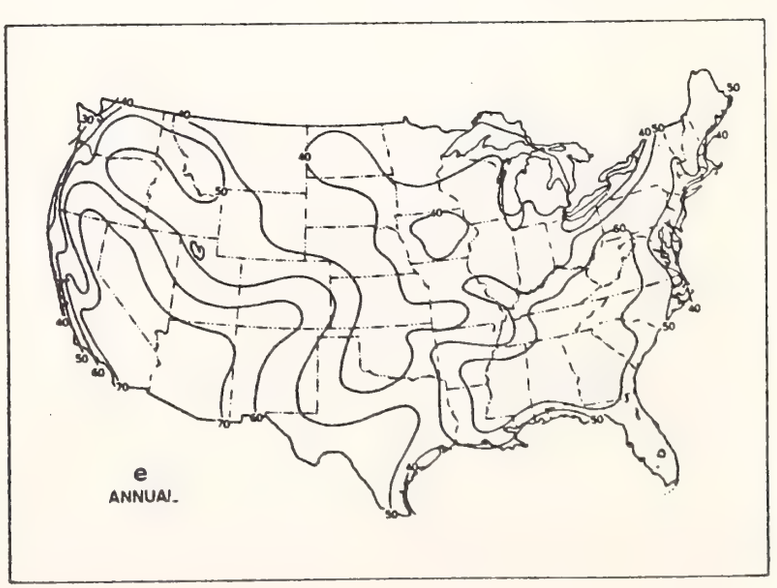
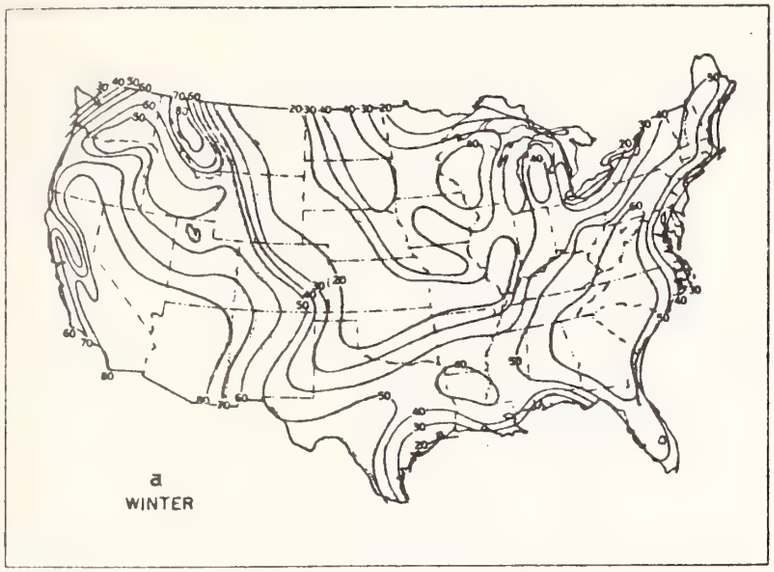
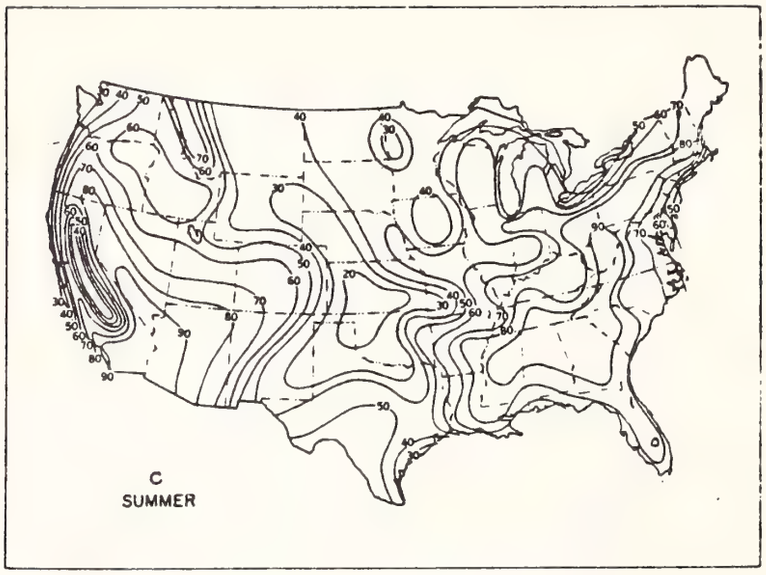
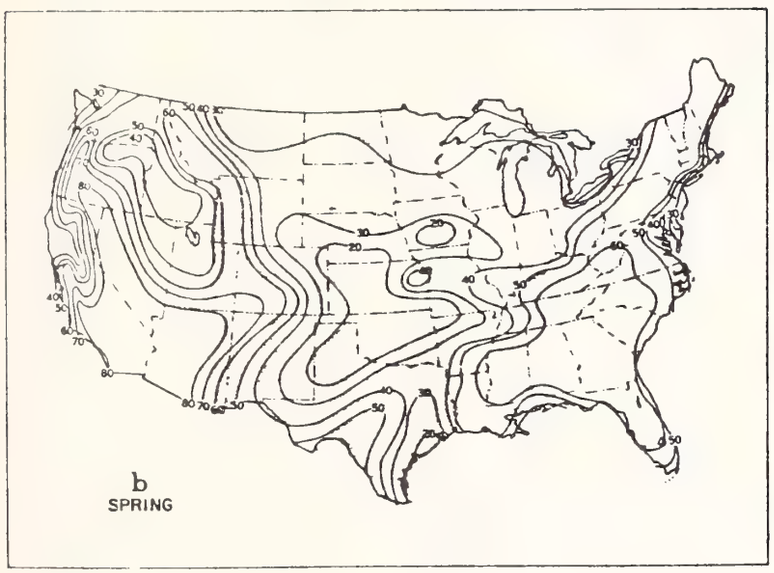


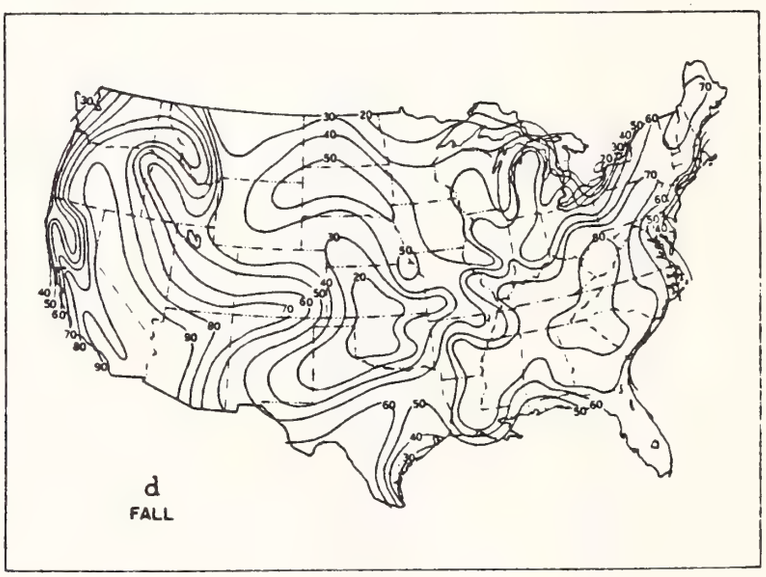
Figure 4-8.--Isopleths of nighttime [(percent cloud cover ≤ 3/10) + (percent wind speed ≤ 7 mph)]/2: (A) Winter, (B) Spring, (C) Summer, (D) Fall, (E) Annual.

Source: Hosler, 1961









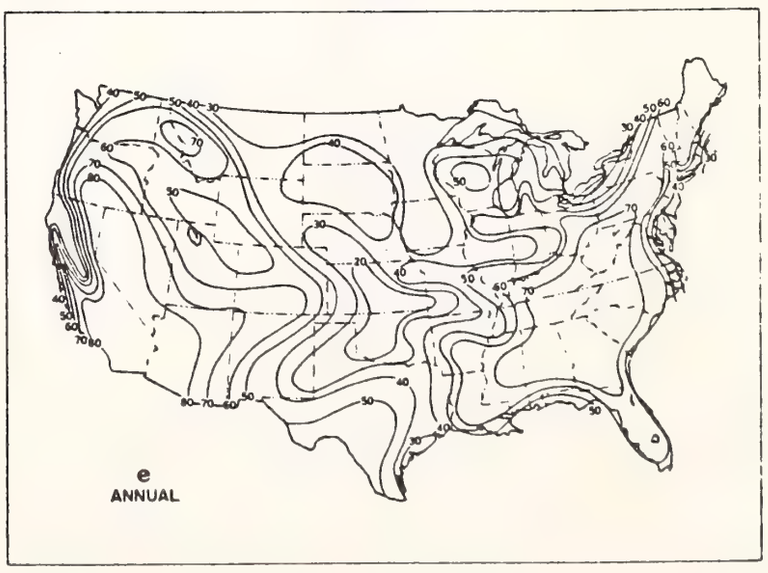
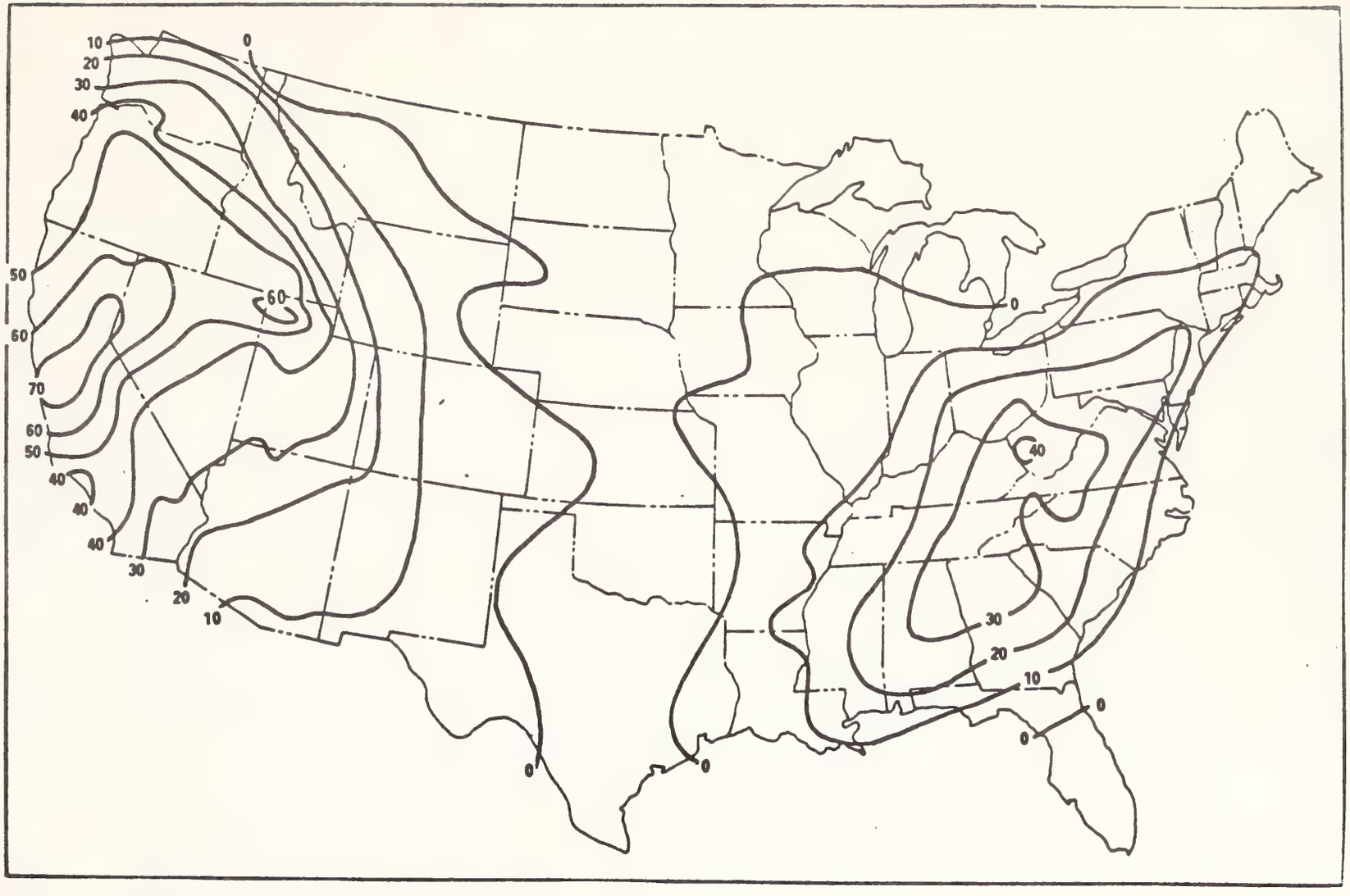


Figure 4-9.--Percent frequency of nighttime wind speed ≤ 7 mph: (A) Winger, (B) Spring, (C) Summer, (D) Fall, (E) Annual.

Source: Hosler, 1961.



Note.--Data are based on forecasts issued since the program began. 1 August 1960 and 1 October 1963 for eastern and western parts of the United States, respectively through 3 April 1970.

Source: Holzworth, 1972

Figure 4.10.--Forecasted Days of High Meteorological Potential (Showing Isopleths for the United States) in a 5-Year Period

4.3.1 Wind Speed and Direction

A fair amount of wind data has been collected in the Butte and Deer Lodge Valleys in past years. Wind data has been compiled in a number of air quality studies conducted by the Air Quality Bureau and also in several MERDI studies.

Wind speeds and direction (one month) recorded in Deer Lodge during 1965-1966 by the Montana State Department of Health are shown in Table 4-3. A large number of the hours sampled recorded wind speeds between 0 and 7 mph and a one-month direction sample (May) indicated prevailing winds from the north. A later study by the Air Quality Bureau (1971-1973) produced a number of wind roses for the Deer Lodge Valley and Anaconda area (Figures 4-11 through 4-16).

Figure 4-11 indicates a westerly prevailing wind in the Deer Lodge Valley near Anaconda. The city of Deer Lodge has a large percentage of its winds from the NNE and NNW, whereas Butte has a predominance of SW and NW winds (Figure 4-13). Figures 4-13 and 4-14 present wind roses for air quality monitoring stations surrounding Anaconda (see Air Quality Report for locations). Figures 4-15 and 4-16 are direction wind roses compiled by the Anaconda Company for stations surrounding the smelter; a large amount of west and southwest winds are indicated. These wind roses indicate that airflow patterns vary within the Deer Lodge Valley.

Wind roses in the Butte Valley have recently been compiled by MERDI (Garrett, 1977). Figure 4-17 shows an annual 24-hour wind rose made from data gathered at the Butte Airport from 1971 to 1975. A predominance of northwesterly (day) winds and southerly (night) winds are indicated. As further evidence of airflow variations within mountain valleys, Figures 4-18 and 4-19 are presented. Airport wind data gathered during the winter of 1976-1977 is given in Figure 4-18, whereas Figure

TABLE 4-3

WIND SPEEDS AND PER CENT OCCURRENCE

DEER LODGE

Year	Month	0-7 mph Hours	Hours Sampled	0-7 mph Per cent	Direction* Per cent Northerly	Per cent Easterly	Per cent Southerly	Per cent Westerly	Per cent Variable	Total Days Sampled
1965	November	242	316	76						
1965	December	173	264	65						
1966	January	102	144	71						
1966	February	568	624	91						
1966	March	438	624	70						
1966	April	414	552	75						
1966	May	434	559	78	47	3	17	12	21	25
1966	June	21	36	58						

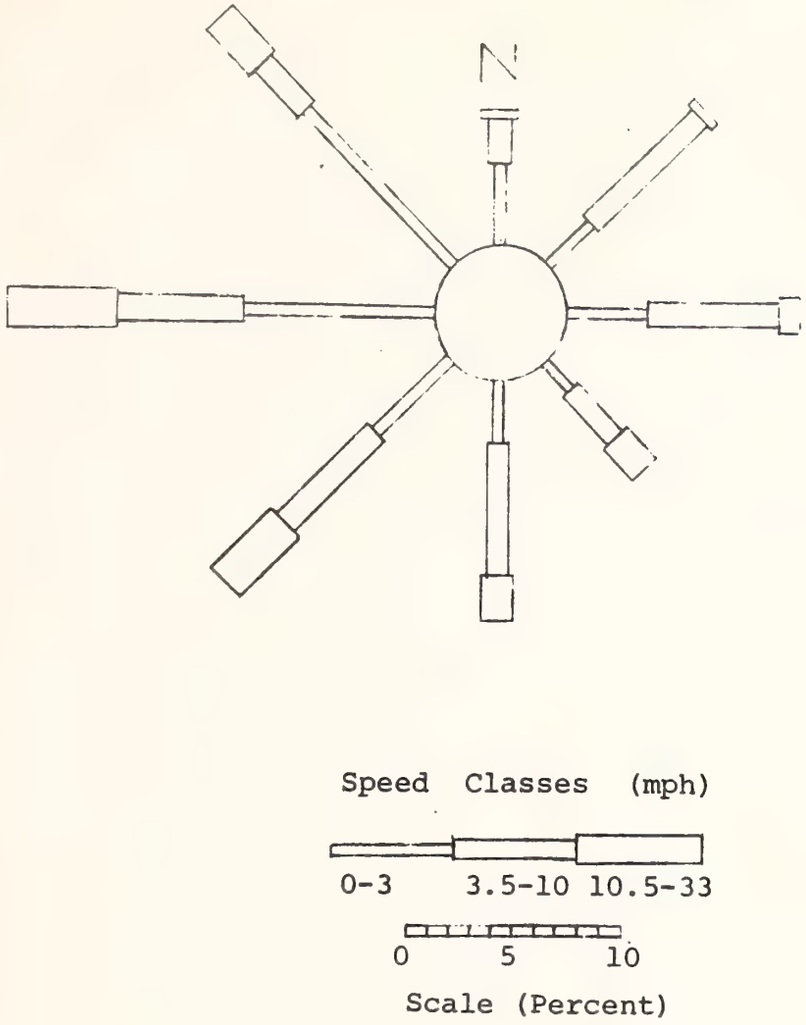
Source: Montana State Department of Health, 1966.

*Indicates direction from which the wind blew.

Source: Montana Department of Health and Environmental Sciences (Air Quality Bureau)

Period: December 71 through January 73

Location: Deer Lodge County (Poor Farm)



Source: Montana Department of Health and Environmental Sciences (Air Quality Bureau)

Period: October 71 through December 71

Location: Deer Lodge County (Baileys)

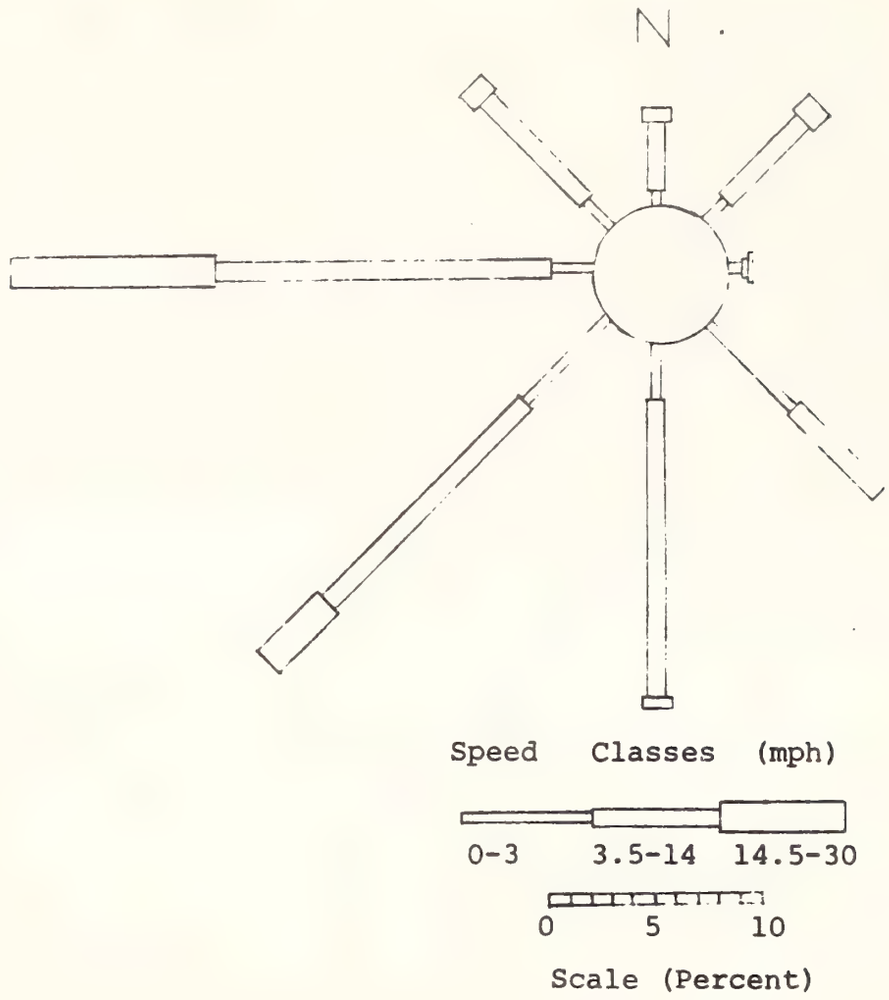
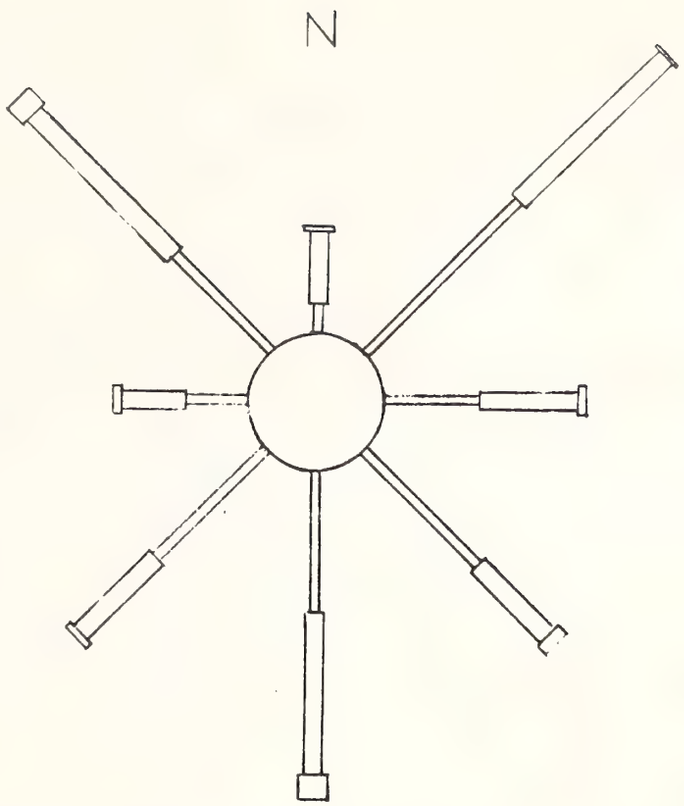


Figure 4-11

Source: Montana Department of Health & Environmental Sciences (Air Quality Bureau)

Period: August 71 through May 72

Location: Deer Lodge (Courthouse)



Source: Montana Department of Health & Environmer Sciences (Air Quality Bureau)

Period: September 71 through March 72

Location: Butte (Fire Station)

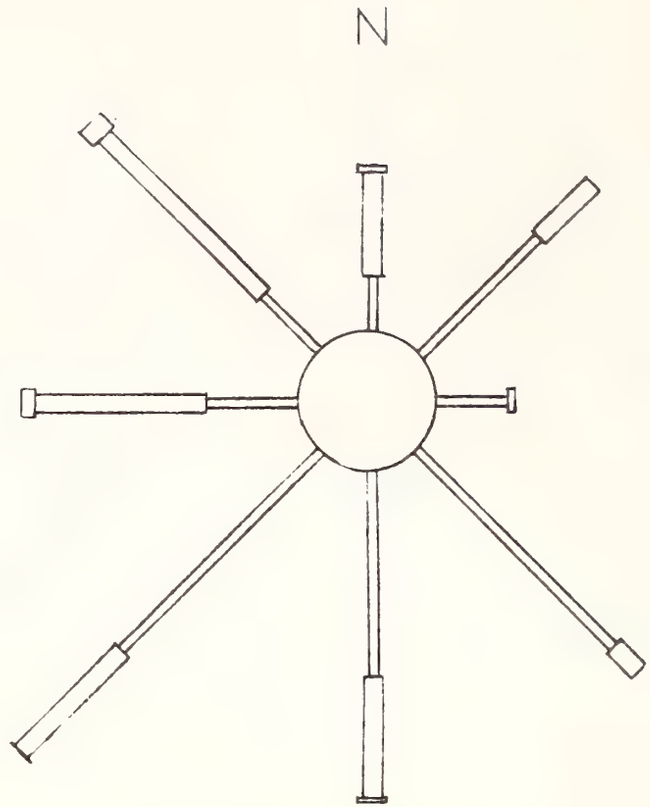
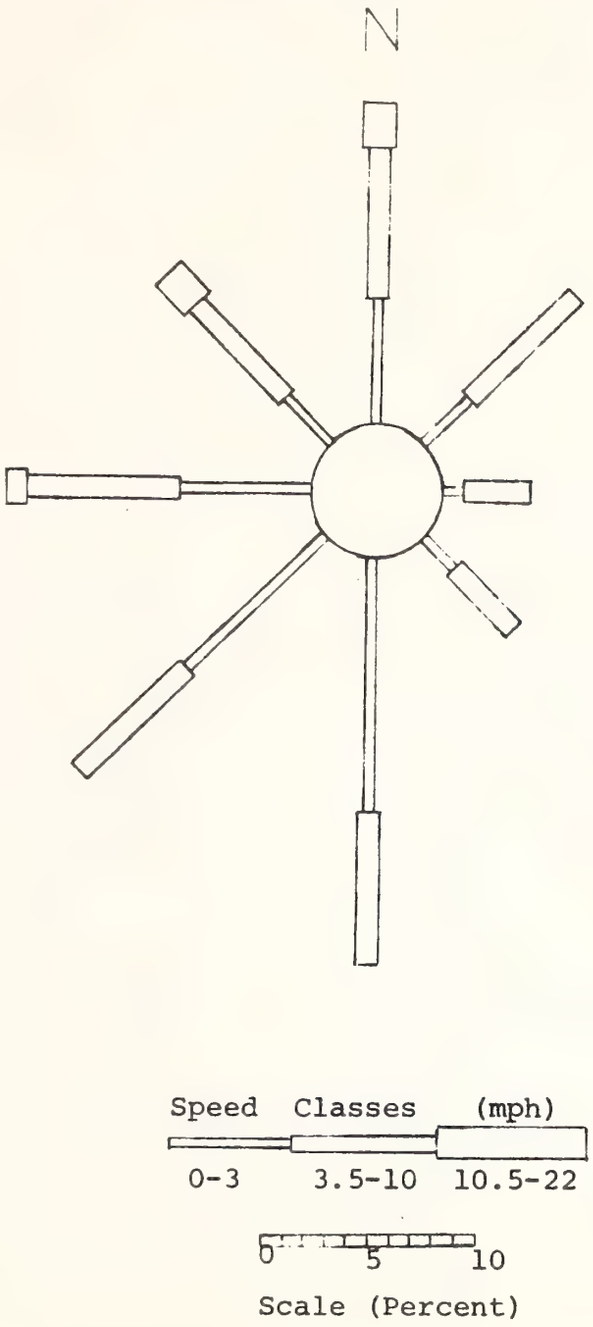


Figure 4-12

Period: June 72 through November 72

Location: Deer Lodge County (Opportunity Main Street)



Period: December 72 through May 73

Location: Deer Lodge County (Kucera Residence)

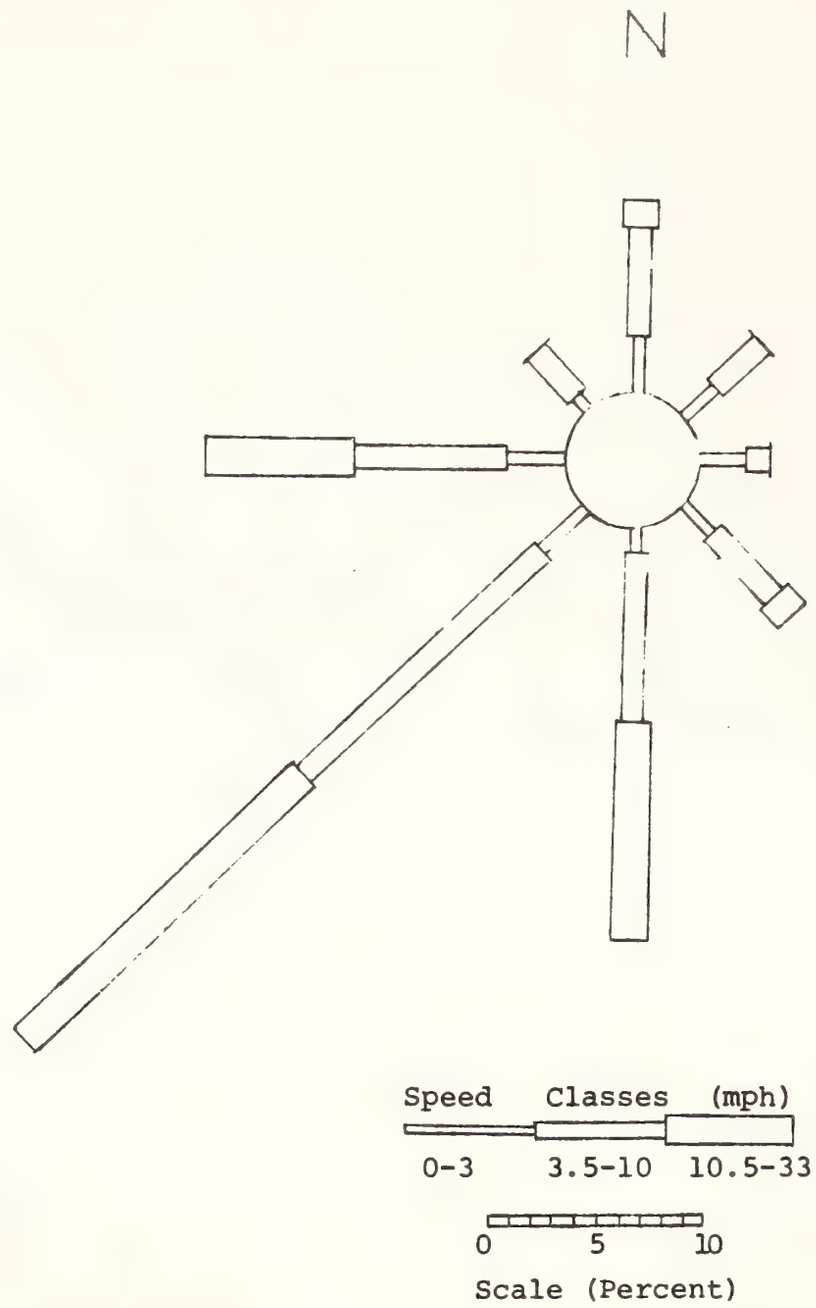


Figure 4-13

Source: Montana State Department of Health and Environmental Sciences Air Quality Bureau

Source: Montana Department of Health and Environmental Sciences (Air Quality Bureau)

Period: February, 1973 through August, 1973

Location: Deer Lodge County (Antelope Creek)

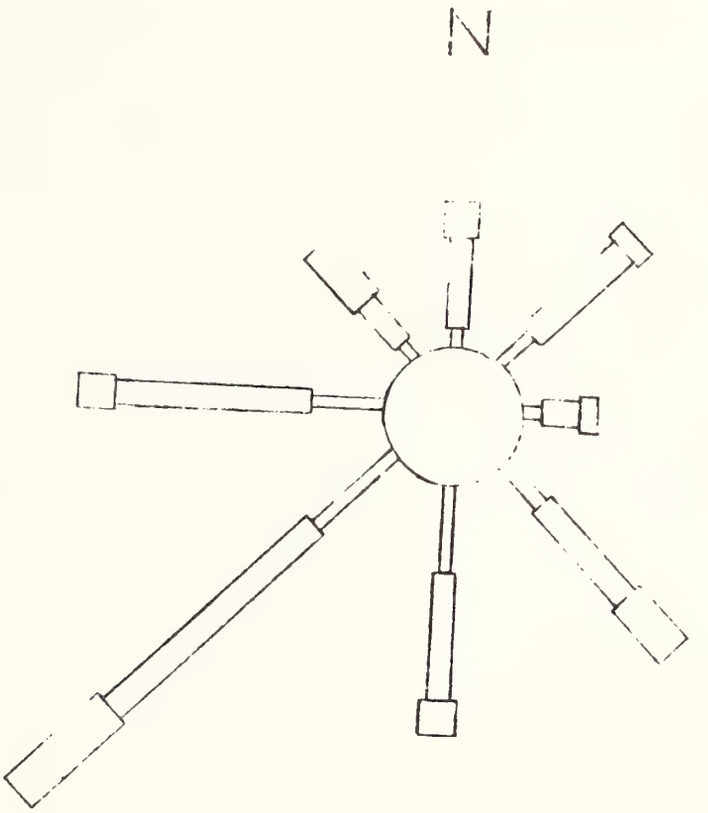


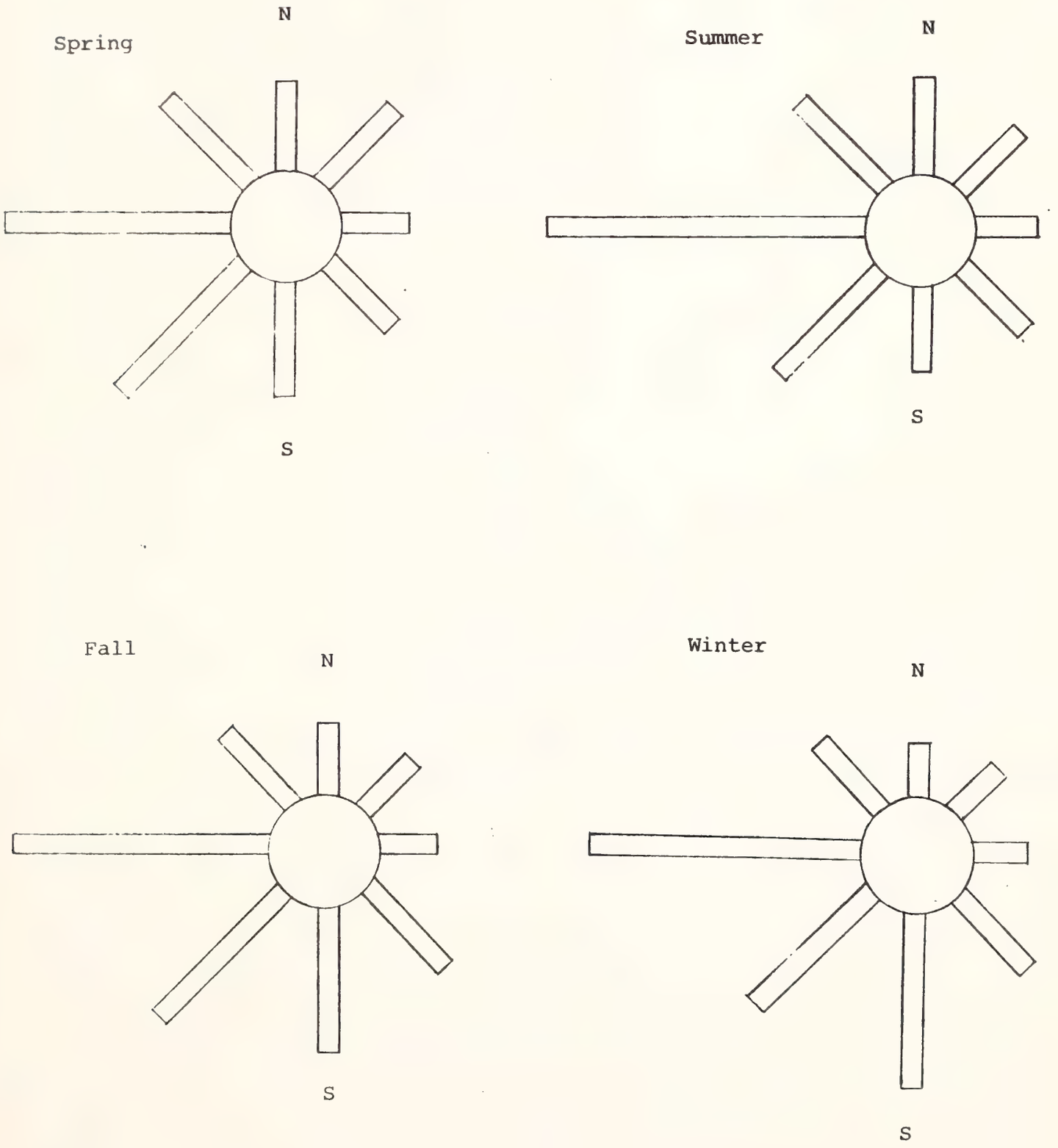
Figure 4-14

Figure 4.15

Seasonal Wind Roses (Direction Only) from Anaconda Company's Flat Station

Period: 1965 and 1967

Location: 4000 feet WNW of main plant complex in the vicinity of the railroad switch yard.



Source: Gelhaus, 1974.

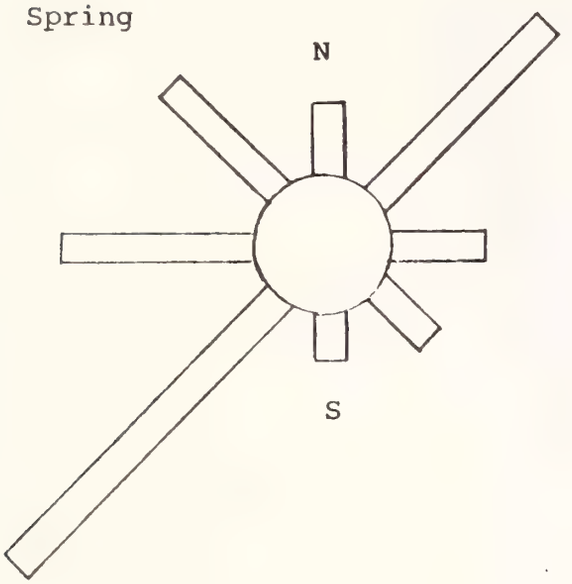
Figure 4.16

Seasonal Wind Roses (Direction Only) from Anaconda Company's Hill Station

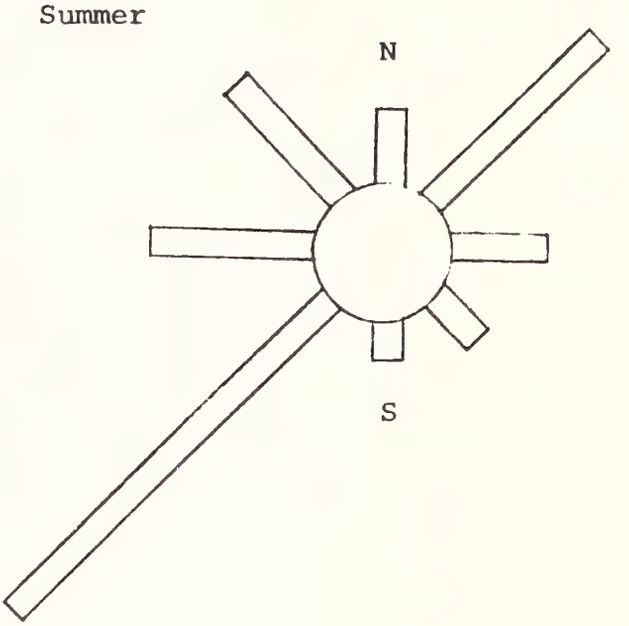
Period: Seven Years

Location: 6000 feet N of main stack

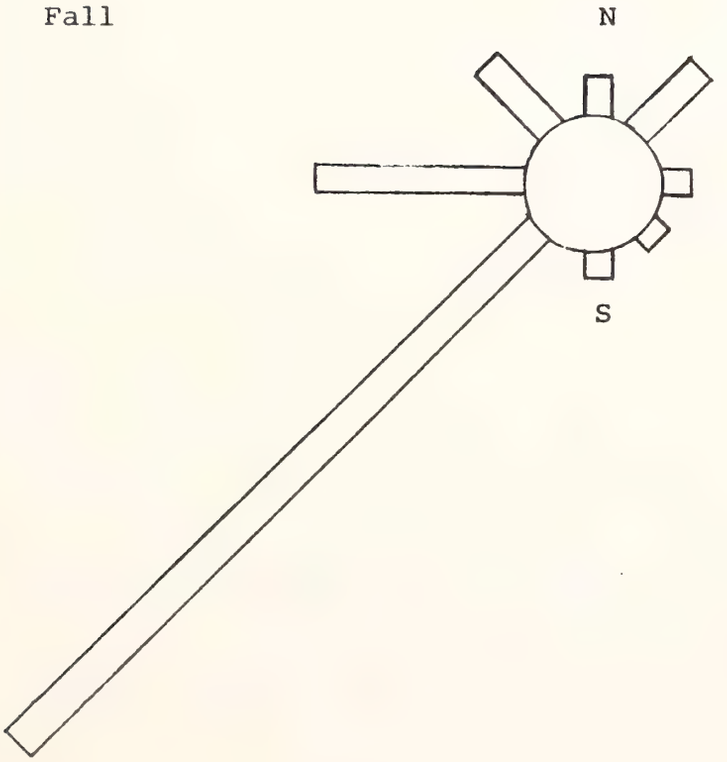
Spring



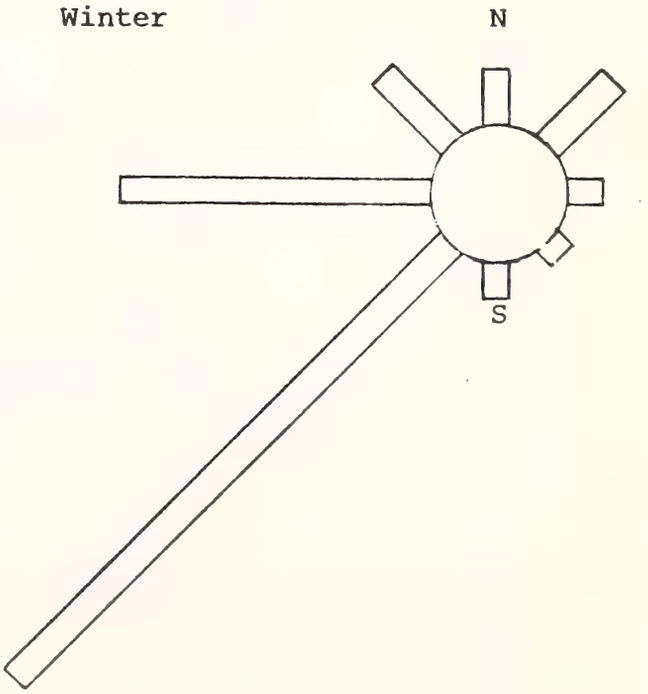
Summer



Fall



Winter



Source: Gelhaus, 1974.

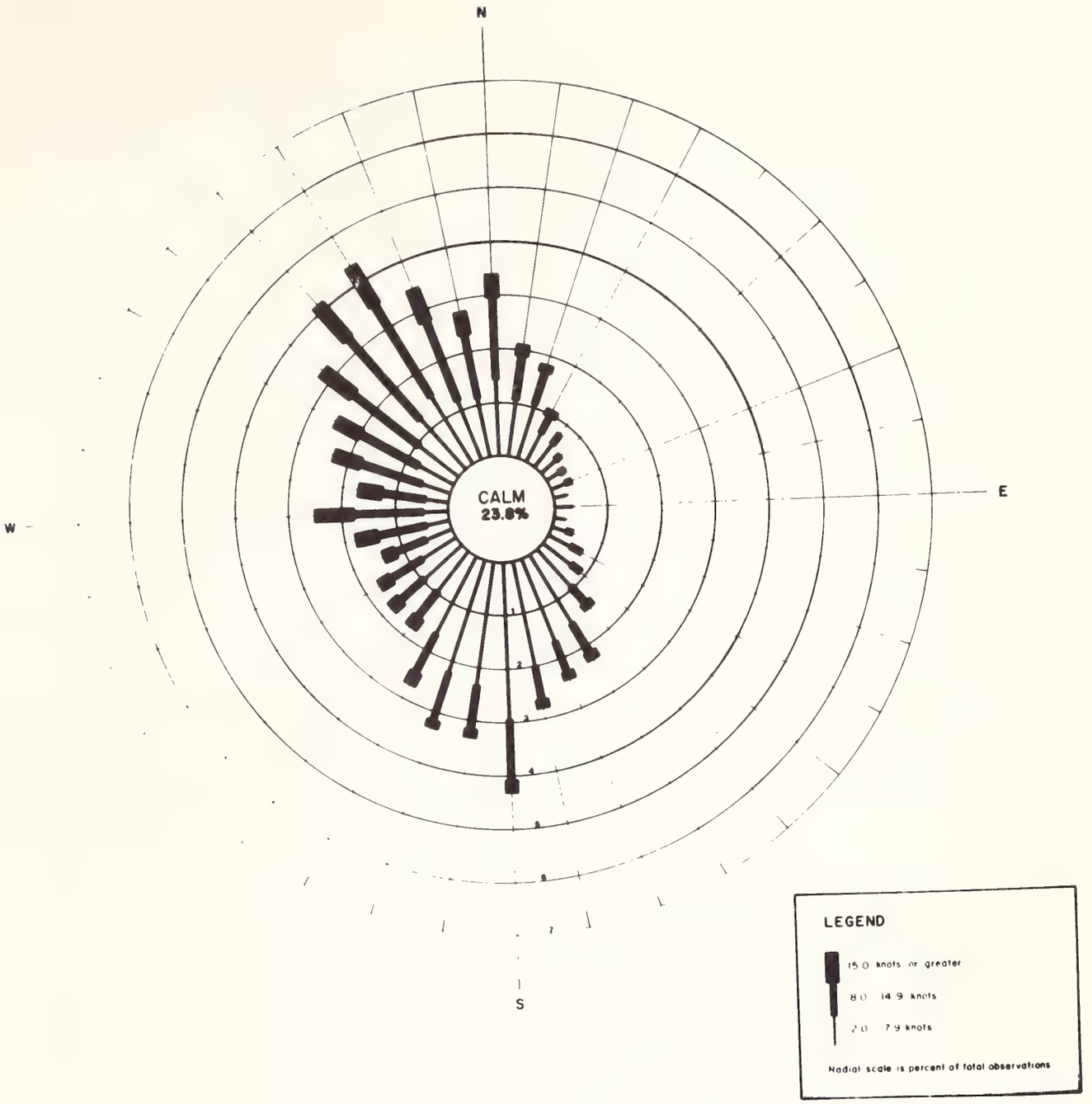


Figure 4-17.--Butte Airport Annual Circadian (24-hour) wind rose (1971-75).

Source: Garrett, 1977.

4-19 gives 1976-1977 winter wind data collected at the MHD CDIF site. Although both locations lie on the valley floor and although they are only about 2 miles apart, the wind patterns differ significantly. These figures demonstrate the need for on-site meteorological monitoring.

As shown in Table 4-1, the Butte area has the lowest maximum and mean speeds of the 5 CSA's. Furthermore, wind roses for the area indicate a substantial amount of low-wind speeds (< 7 mph). In the Anaconda area, surface winds as recorded by the state in valley floor locations near Anaconda are predominantly westerly through southerly with a predominant speed range of 3.5 to 30 mph (Montana Air Quality Bureau, 1974). No wind data was available for the Whitehall area. Low wind speeds and relatively poor pollutant dispersal can be expected in the mountain-valley terrain of the Butte-Anaconda region.

4.3.2 Fog Occurrences

As shown in Table 4-2, the Butte area has the fewest number of days with heavy fog per year when compared to the other 3 CSA's with data. The winter months can be expected to record a higher number of foggy days.

4.3.3 Air Pollution Potential

Based on Figures 4-1 through 4-3 and 4-7 through 4-10, the Butte-Anaconda area has the highest meteorological potential for air pollution of the five CSA's. Out of the four CSA's (excluding Livingston) covered in Figures 4-1 to 4-3, Butte has the largest percent frequency in the stable category. Furthermore, Figures 4-7 through 4-9 show an annual inversion frequency of 40 to 45 percent for the Butte-Anaconda area and a 60 percent frequency of nighttime winds less than 7 mph. According to Holzworth's forecasts, (Figure 4-10), the Butte-Anaconda area has between 10 and 20 days of high meteorological potential for air

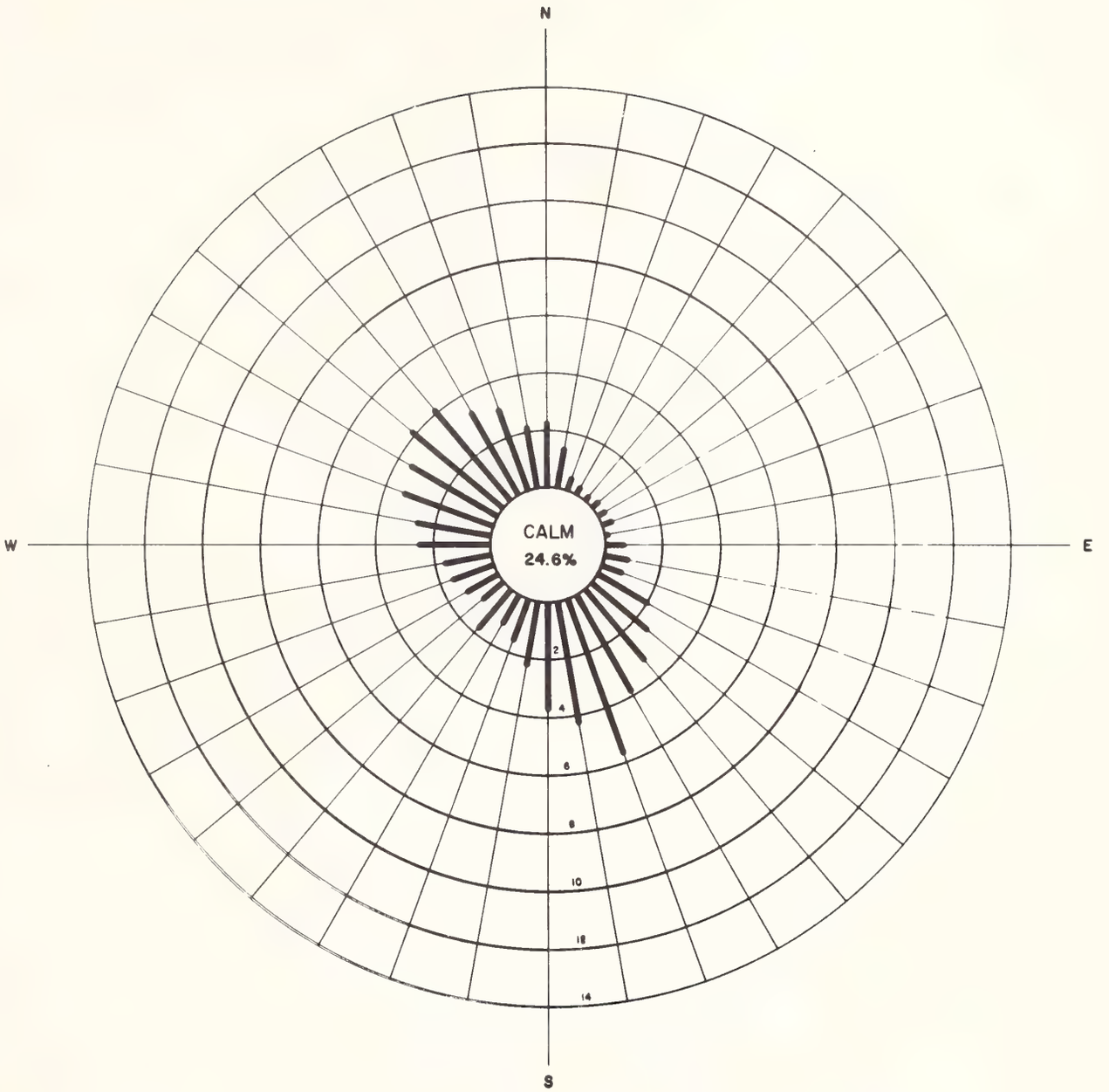


Figure 4-18.--Winter 1976-1977 Airport Wind Data

Source: Garrett, 1977.

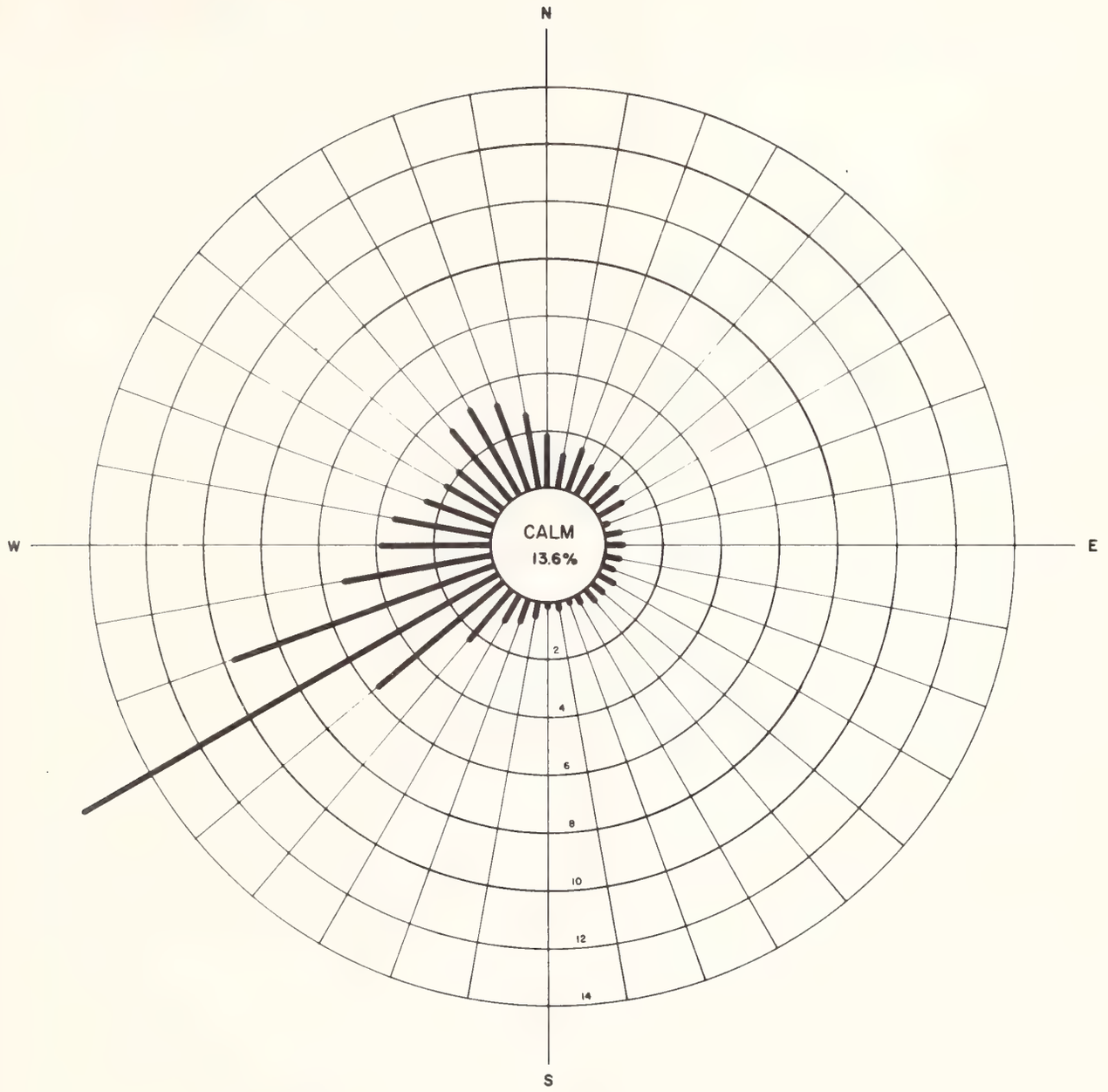


Figure 4-19.--Winter 1976-1977 MHT CDIF Wind Data

Source: Garrett, 1977.

pollution in a 5 year period. Although the available information is quite general, it does indicate the need for more specific study to better define the meteorological parameters contributing to the air pollution problem.

4.4 Glasgow Air Force Base Area

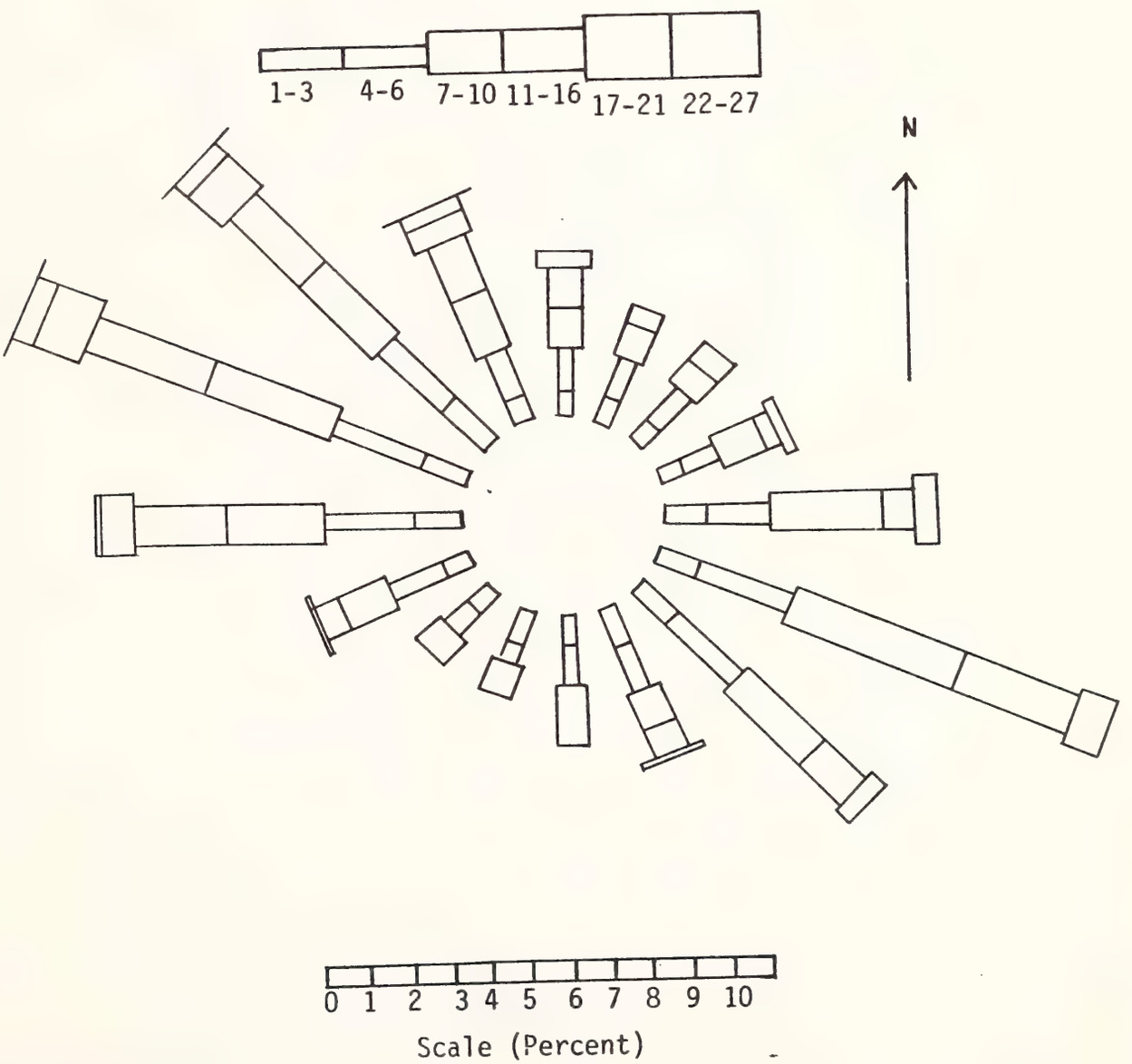
4.4.1 Wind Speed and Direction

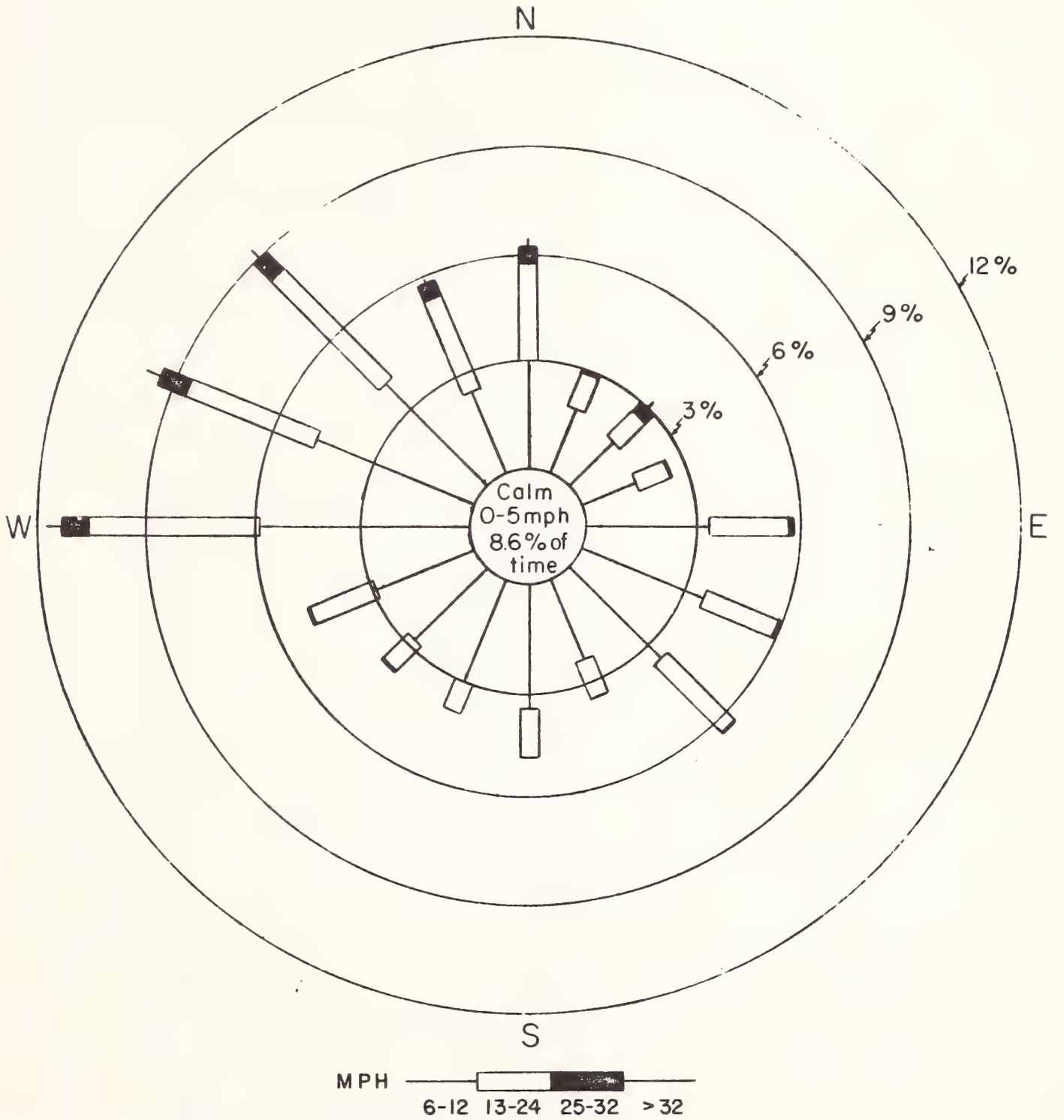
Wind speed and direction data has been collected for both the Glasgow Airport and the Glasgow Air Force Base (GAFB). A wind rose for the Glasgow Airport is shown in Figure 4-20. Prevailing winds are from the northwest quadrant, but the southeast quadrant also produces from 29 to 30 percent of the winds; furthermore, a substantial amount of wind in the 8 to 18 mph range is indicated. Figure 4-21 is a wind rose for the GAFB, 17 miles from the city airport, developed from Strategic Air Command wind data (Table 4-4). The general wind pattern originates from the northwest quadrant approximately 45 percent of the time, whereas a secondary wind pattern blows from the east-southeast 20 percent of the time (Federal Energy Administration, 1975, p. 103). Although the two wind roses are somewhat similar, they cannot be correlated without additional information. Since a meteorological station is being installed at GAFB by MERDI, the needed information should be available in the future.

As shown in Table 4-1, Glasgow has lower maximum and mean wind speeds than Livingston, Great Falls, or Billings. Furthermore, Glasgow had a higher percentage of time in the 0 to 7 mph wind speed range than the above cities; Butte wind speed range data was not comparable to the figures given in Table 4-1. Despite these factors, Glasgow generally is considered to have good dispersion.

4.4.2 Fog Occurrences

Figure 4-20.--Wind Rose





Source: Strategic Air Command.

Figure 4-21.--Wind Speed and Direction for Glasgow, Montana Air Force Base

Table 44.--Direction and Velocity of Surface Winds

MPH	Direction	N	NNe	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
6-12	% of time	3.0	1.9	1.7	1.6	3.3	3.5	3.5	2.4	3.4	3.0	2.8	2.9	5.8	4.7	4.0	2.5
13-24	% of time	2.8	1.0	1.1	1.0	2.3	2.4	2.8	1.0	1.4	.9	1.0	1.9	4.8	3.9	4.3	2.8
25-32	% of time	.5	.1	.2	.1	.2	.1	.1	.0	.0	.0	.1	.1	.8	.9	.7	.5
32	% of time	.2	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.4	.4	.3	.1
	Total	6.5	3.0	3.1	2.7	5.8	6.0	6.4	3.4	4.8	3.9	3.9	4.9	11.8	9.9	9.3	5.9

*Data compiled by Department of the Air Force (see Appendix).

Note.--Calm conditions (0-5 mph) occurred 8.6 percent of the time.

Source: FEA, 1975

Glasgow has an average of 12 days of heavy fog per year (Table 4-2) as recorded in the NOAA Local Climatological Data. During the period 1968-1974, heavy fog surrounded Glasgow an average of 14.3 days per year (Federal Energy Administration, 1975, p. 111). The highest frequency was found from November to March, when 1 to 3 days of heavy fog generally occurred each month. Foggy conditions of a less dense nature were found more often.

4.4.3 Air Pollution Potential

Figures 4-1 through 4-3 and 4-7 through 4-10, give a general indication of the air pollution potential throughout the U.S.; they indicate that Glasgow has a low potential for air quality problems. It has a large amount of time in the neutral category (Figure 4-2) which is conducive to the dispersal of pollutants. Furthermore, the annual inversion frequency (Hosler, 1961) shown in Figure 4-7 indicates the formation of inversions only 35-40 percent of the time. Finally, Holzworth (1972), predicts zero days of high meteorological potential for air pollution in a 5-year period (see Figure 4-10).

Although further study is needed to better define the meteorology of the area, Glasgow appears to have meteorological conditions favorable to the dispersal of air pollutants.

4.5 Great Falls Area

4.5.1 Wind Speed and Direction

The wind rose developed by the National Weather Service for Great Falls (Figure 4-22) shows the dominance of southwesterly winds. Furthermore, the majority of winds in the 19 to 31 mph range were from the southwest.

As indicated by Table 4-1, Great Falls has high maximum and annual mean wind speeds. Second only to Livingston, the area has a record high

available through the Earth Sciences Department at Montana State University in Bozeman, Montana. However, the data is not summarized and would have to be compiled by hand or key punched so that it could be run through a wind rose program on MERDI's computer. Either method would require considerable time and money; an estimate of the computer time necessary falls between $600 and $1000. Because of these problems, no attempt was made to develop a wind rose for this report.

Table 4-1 presents wind data for the Livingston area collected by Obermeir (1976). A record high wind of 88 mph and an annual mean speed of 14.1 mph, the highest at any of the sites, were recorded at Livingston. Furthermore, the winds, which are predominantly from the southwest, spend a substantial percentage of the time in the greater than 23 mph wind speed range. These figures support the rumor that Livingston is Montana's "windy" city.

4.6.2 Fog Occurences

Since there is not a National Weather Station at Livingston, no data on the number of days of fog per year were available.

4.6.3 Air Pollution Potential

Since air pollution is not considered to be a problem in the Livingston area, very little work has been done on the air pollution potential of the area. Figures 4-1 through 4-3 and 4-7 through 4-10 generally indicate that the meteorological potential for air pollution in the vicinity of Livingston is similar to that around Billings. Furthermore, the amount of wind in the area decreases the pollution potential.

Despite these generalizations, little can accurately be said about the Livingston CSA until baseline data is gathered and studies are made.

4.7 Conclusions

Enough information is available to draw some general conclusions about the air pollution meteorology at the five sites. However, the need for more study cannot be over-stressed, especially if meteorology is a major factor in selecting the ETF site.

Based on the available data, the following generalizations about the 5 CSA's can be drawn:

- The Butte-Anaconda CSA probably has the worst meteorological conditions for diluting and dispersing air pollutants (Whitehall's meteorological conditions are unknown);
- Although Billings is in eastern Montana and is subject to frequent winds, the area has numerous nocturnal inversions, resulting in meteorological problems;
- The Great Falls CSA has frequent winds and it generally is not considered to be an area with high meteorological potential for air pollution;
- Although no air pollution meteorology studies have been done, the Glasgow CSA is thought to have meteorological conditions favorable to the dispersal of pollutants; and
- Since no meteorology surveys have been done in the Livingston area, the only valid conclusion that can be drawn is that Livingston has the greatest frequency of high winds.

These general conclusions can only be used to show a broad trend - the eastern Montana plains have meteorological characteristics better suited to handling air pollutants than the western Montana valleys. Furthermore, the available data is taken only at Weather Bureau and Flight Service Stations; therefore, it likely will not apply to the full CSA. For example, the wind patterns in the Butte valley vary substantially from the CDIF site to the

airport (approximately two miles apart).

These problems demonstrate the need for on-site meteorological monitoring at the candidate sites. Until the meteorology of these areas is better defined, impact analysis of specific sites cannot proceed.

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5.0 GROUNDWATER RESOURCES IN FIVE MONTANA CANDIDATE SITE AREAS

5.1 Introduction

The purpose of this report is to examine the groundwater availability and quality in each of the 5 candidate site areas (CSA's). Based on available information, the amount of groundwater existing in each area is quantified. However, the literature review has shown that such information is not always complete. Consequently, the need for further hydrogeologic study is stressed.

In the report, each CSA will be treated separately; furthermore, where applicable, the CSA's will be broken down into districts based on the drainage basins and valleys within their boundaries.

The availability section presents the amount of groundwater in storage in the area, examines the quantity available to wells, approximates drill depths, and scrutinizes the chances for an industrial supply of groundwater. Groundwater quality data is presented in tables and discussed in the report.

5.2 Billings Area

5.2.1 Groundwater Availability

In the alluvial aquifer in the Yellowstone River Valley from the Yellowstone County line downstream to Big Horn, approximately 167,000 acre-feet of groundwater in storage is available to wells (Montana Water Resources Board, 1969, p. 80). The aquifer, which occupies 125,000 acres, receives a perennial recharge of 28,000 acre-feet. Because the Cretaceous Formations will yield only small quantities of poor quality water and because the Judith River Formation and Eagle Sandstone will produce only small quantities of fair quality water (Gosling and Pashley, 1973), the unconsolidated alluvium appears to be the best source of large yields of groundwater. These unconsolidated deposits are approximately 50 feet thick in the central part of the Yellowstone Valley;

furthermore, the thickness of the alluvium increases to about 120 feet along the northern boundary (Gosling and Pashley, 1973).

Well yields will vary depending on the thickness of the unconsolidated deposits, but LaRocque (1966) estimates that the alluvium in the Yellowstone River Valley will yield between 50 and 500 gpm to properly located and constructed wells. Well logs from the Montana Bureau of Mines and Geology-Hydrology Division indicate possible yields of 100 to 500 gpm from river gravels, whereas Sherman Sollid (Soil Conservation Service Geologist) indicated that there is a potential for developing yields exceeding 500 gpm from the alluvial deposits along the Yellowstone River.

Depths to the water table are usually less than 50 feet (LaRocque, 1966), and many areas have problems with waterlogging when the water table approaches the surface during the irrigation season (Gosling and Pashley, 1973). Groundwater movement in the valley is generally toward the river where it contributes to the river flow during dry periods.

Comanche Basin, which lies northwest of Billings, has the potential to yield considerable quantities of water at depths less than sixty feet (Hall and Howard, 1929). Quaternary alluvium and lake bed deposits, which range from 0 to 75 feet in thickness, serve as the principal aquifer in the basin.

Shallow groundwater aquifers generally are not available outside the river valley and the Comanche Basin area. The potential of deeper aquifers is relatively unknown; however, two aquifers (the Kootenai and the Madison) may produce quantities of groundwater sufficient for an industrial supply. For example, yields exceeding 500 gpm have been obtained from the Kootenai formation, at depths ranging from 800 to 2500

feet, in the Billings area (Sollid, 1977). A well drilled into the Kootenai at the Yellowstone Country Club in Billings produces water from a depth of 2689 feet.

The Madison Limestone Formation, which is currently under study by the U.S. Geological Survey (USGS), has the potential for yielding large amounts of groundwater. At a depth of 3000 feet or greater in the Billings area, the formation has reported well yields elsewhere ranging from 50 to 1400 gpm (Miller, 1976, p. 1). Since the potentiometric surface is about 1000 feet above the land surface along the Yellowstone River, flowing wells could be expected in the Billings area. However, further information is needed before the supplies from the Madison can be documented.

5.2.2 Groundwater Quality

Groundwater in the Billings area tends to be poorer in quality than groundwater in western Montana. In the alluvium and terraces along the Yellowstone River near Billings, groundwater quality ranges from excellent to poor for domestic and irrigation use (Montana Water Resources Board, 1969, p. 80). Water quality should be good in the alluvial aquifer, except for some problems with surface contamination (Sollid, 1977). However, Gosling and Pashley (1973) indicate that, except for small areas, the groundwater in the Billings area generally is mineralized too highly to be used for human consumption.

The best groundwater in the area contains from 300 to 800 ppm (mg/1) total dissolved solids (TDS); however, dissolved solids levels are usually in the 1000 to 3000 ppm range (Feth, 1966). A summary of twenty analyses of groundwater from wells in the valley alluvium shows an average of 1900 mg/1 (ppm) dissolved solids (Gosling and Pashley, 1973). As shown in Table 5-1, groundwater constituents that are par-

ticularly high in the area are sodium, sulfate, and bicarbonate. Other water quality data for Yellowstone and Treasure counties is presented in USGS Water Supply Paper 599 (p. 18-27), but it might be outdated since its publishing date is 1929.

Water obtained from the Kootenai Formation is high in dissolved salts (Na=1478 ppm) and high in temperature (104°F)--Sollid, 1977. No other data on the Kootenai was available at the time of this report.

Groundwater quality in the Madison Formation is relatively unknown due to the lack of development in the deep aquifer. However, a preliminary evaluation of the aquifer is given by W. R. Miller, 1976. His study indicates that groundwater from the Madison in the Billings area contains approximately 3000 ppm TDS; furthermore, between 50 and 75 percent of the dissolved constituents are calcium, magnesium, and sulfate, whereas less than 50 percent are sodium, potassium and chloride.

5.2.3 Billings Area Summary

As in other areas, the alluvium along the Yellowstone River and its tributaries is the best proven source of groundwater. The possibilities for an industrial supply of water look good; however, large withdrawals may affect the flow of the Yellowstone River, thereby conflicting with the present surface water moratorium. For example, since the surface water in a stream is closely related to the water stored in the alluvium along the channel (bank storage), any large withdrawal of groundwater from the alluvium in the vicinity of the channel may lower the water level in the stream. This situation has not developed yet, but it could cause problems with future use of alluvial groundwater.

Deeper aquifers have an undocumented potential for producing industrial supplies of groundwater. The Kootenai Formation, although

Table 5-1.--Summary of Analyses of Groundwater from Wells in Alluvium near Billings

[Analyses by Montana State Board of Health]

	Concentrations in milligrams per liter									
	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids[2]	Total hardness ($CaCO_3$)
Average for 20 samples	190	117	209	354	1,020	30	1.2	19	1,900	857
NW¼NW¼ sec. 8, T. 2 S., R. 24 E. high dissolved solids	465	300	630	435	3,230	30	1.2	1.4	5,330	2,400
NW¼SE¼ sec. 25, T. 2 S., R. 22 E. low dissolved solids	56	26	26	238	78	16	1.0	1.0	298	245
Recommended limit for drinking water[1]	-----	-----	-----	-----	500	250	[3]1.3	45	500	------

[1]U.S. Public Health Service drinking water standards, 1962.
[2]Calculated.
[3]Recommended upper limit for an annual average maximum air temperature of 58.4–63.8°F.

Source: Gosling and Pashley, 1973.

known to produce yields greater than 500 gpm, has quality problems. On the other hand, the Madison is untapped in the Billings area, and further studies are needed to determine the quantity and quality of water available. Again, intensive studies will be necessary when a specific site is selected.

5.3 Butte-Anaconda Area

5.3.1 Upper Silver Bow Creek (Butte) Valley

5.3.1.1 Groundwater availability

The principal aquifer in the Upper Silver Bow Creek drainage basin is the alluvium in the 23 square miles of valley fill in the central part of the basin (Botz, 1969, p. 20). Geologically, the basin (composed principally of granitic rocks and alluvium) lies entirely within the Boulder batholith. Approximately 440,000 acre-feet of groundwater is in storage in the upper 200 feet of saturated alluvium in the valley (Botz, 1969, p. 1).

Quantities of groundwater generally available to properly located and constructed wells will range between 50 and 500 gallons per minute (gpm) (LaRocque, 1966). Reported well yields average 80 gpm from depths of 2 to 88 feet (Montana Water Resources Board, 1969, p. 87). Data indicates that there is a potential for developing yields around 500 gpm from the Tertiary sediments in the Butte valley (Sollid, 1977); however, drill depths exceeding 500 feet would be required. Moreover, since the valley is essentially a closed basin, one or more high-producing wells might effectively "mine" the groundwater due to a lack of sufficient recharge. Therefore, the chances of producing a well with a sustained yield of 500 gpm or more are marginal.

Groundwater recharge to the basin comes from two sources:

- The streams (Silver Bow Creek, Blacktail Creek, Basin Creek) entering the valley; and
- The 17,000 acre-feet per year of precipitation falling upon the valley.

Scattered measurements indicate little annual or net change in the configuration of the water table (Botz, 1969). After infiltration into the alluvial aquifer, the groundwater flows north at a gradient of 15 feet per mile until it reaches the north end of the valley, where the direction of flow changes to west. At the south end of the valley, the water table is relatively deep beneath the surface. At the north end, the water table is very close to the surface; as a result, the area is marshy.

Wells in the valley are used chiefly for stock, domestic, and industrial purposes.

5.3.1.2 Groundwater quality

With the exception of near Silver Bow Creek, water quality generally is good, and pollution is not a serious problem (Botz, 1969, p. 20). Because of the industrial and municipal pollution in Silver Bow Creek, groundwater near the stream is of poorer quality than that in surrounding areas.

Analyses of wells in the valley indicate that the groundwater is a calcium bicarbonate type with a total dissolved solids content ranging between 70 and 650 milligrams per liter (mg/1) (Botz, 1969, p. 18). Table 5-2 (Botz) shows a summary of chemical analyses of water from wells, springs, and streams in the Upper Silver Bow Creek drainage area.

Table 5-2.--Concentration of dissolved constituents in water from springs, streams, and wells in the Butte Valley (milligrams per liter).

	Ion or measurement									
Type of sample	Ca	Mg	Na	K*	Cl	SO_4	CO_3	HCO_3	pH	Total dissolved solids, calculated
Springs										
Minimum	2	3.2	4.5	1.4	1.9	8	0	27	6.80	50
Average	20	5.9	7.3	2.8	3.4	33	0	62	7.46	134
Maximum	40	8.6	10.8	3.5	6.9	65	0	96	7.85	215
Streams										
Minimum	11	3.2	4.5	2.2	.6	6	0	17	6.78	67
Average	20	5.3	9.0	4.3	5.4	18	0	77	7.58	137
Maximum	37	9.1	37.0	7.3	33.7	34	0	138	8.00	246
Wells										
Minimum	13	1.9	5.7	2.2	2.0	4	0	31	6.40	70
Average	32	9.2	13.4	3.3	9.3	51	0	95.5	7.18	216
Maximum	105	37.8	50.0	5.3	129.7	269	0	172	8.20	649

*Water from only 3 springs, 3 streams, and 8 wells was analyzed for potassium.

Source: Botz, 1969.

5.3.2 Deer Lodge Valley

5.3.2.1 Groundwater availability

The principal source of groundwater in the Deer Lodge Valley is the upper few hundred feet of unconsolidated valley fill (Konizeski, et al., 1968, p. 12). Approximately 544,000 acre-feet of groundwater is available to wells in the 64,000 acre alluvial basin (Montana Water Resources Board, 1969, p. 88). Most of the wells penetrating the Quaternary and Tertiary sediments can tap the water table at depths of 0 to 150 feet depending on their location.

Groundwater yields to properly constructed wells range between 10 and 1200 gpm (Montana Water Resources Board, 1969, p. 89) depending on the well site. Generally, wells having the highest yields are on the flood plain of the Clark Fork or the coalescent fans of Warm Springs and Mill Creeks (Konizeski, et al., 1968, p. 2). These areas have large amounts of Quaternary alluvium, considered to be the best water source in the valley (personal communication with Pete Norbeck, Bureau of Mines hydrologist, July 1977).

Seasonal fluctuations in the water table are generally small, indicating that recharge of the aquifer is about equal to discharge. Movement of groundwater is generally toward the Clark Fork at a rate less than 3 feet/day.

Groundwater is the principal source of water for municipal and domestic use in the Deer Lodge Valley. About 7000 acre-feet/year of groundwater is pumped from six municipal, four state institution, two irrigation, and several hundred domestic and

stock wells. Almost 50 percent of the 7000 acre-feet/year is pumped from 3 municipal wells in Anaconda which tap the alluvium along Warm Springs Creek.

Despite this withdrawal, Konizeski, et al. determined that recharge to the valley fill (alluvium) is sufficient to cover additional groundwater withdrawals. Although there is a great variation in water yielding properties in the valley, the flood plain of the Clark Fork, and the coalescing fans of Mill and Warm Springs Creeks show good potential for yielding large amounts of groundwater. For example, a well near Deer Lodge was tested at 1300 gpm with 32 feet of drawdown after 24 hours of pumping (Konizeski, et al., 1968, p. 37). Properly constructed and developed wells, which tap both the Quaternary and Tertiary sediments in these areas, will yield 1000 gpm or more according to a United States Geological Survey (USGS) study. The alluvial fans along Racetrack and Dempsey Creeks show possibilities of producing up to 300 gpm or more. However, it is recommended that the area be test drilled before a production well is drilled to assure that the chosen site will produce expected yields. Throughout the rest of the valley, the upper few hundred feet of sediment generally will yield water sufficient only for stock and domestic use.

5.3.2.2 Groundwater quality

Groundwater quality in the Deer Lodge Valley generally is considered to be excellent (less than 500 parts per million (ppm) total dissolved solids) for both domestic and irrigation use (Montana Water Resources Board, 1969, p. 88). Some possible

exceptions would be areas near the Anaconda Company's waste water discharge and settling ponds and near homes or communities with poor sewage disposal systems.

5.3.3 Silver Bow-Divide Valley

5.3.3.1 Groundwater availability

The Silver Bow-Divide Valley, which lies southeast of Butte, occupies both sides of the Continental Divide; north of Deer Lodge Pass, it drains into the Clark Fork, and south of the pass, it drains into the Big Hole River and eventually into the Missouri River. In the northern end of the valley, groundwater yields of more than 500 gpm to properly located and properly constructed wells can be expected (LaRocque, 1966, HA-217). Stauffer Chemical Company, an industrial plant in the northern end of the Silver Bow-Divide Valley, has a well field consisting of 7 wells, each capable of producing between 350 and 500 gpm (Montana Bureau of Mines & Geology-Hydrology Division, Well Logs). Further south, an irrigation well produces 350 gpm from shallow aquifers according to Montana Bureau of Mines and Geology (MBMG) well logs.

Approximately 1,100,000 acre-feet of groundwater is available to wells in the Big Hole Basin (Montana Water Resources Board, 1969, p. 28); a portion of this storage might be available to a well field depending on the effects on prior appropriators and on dewatering the Big Hole River. According to the Montana Water Resources Board, the Big Hole Basin (which includes the southern portion of the Silver Bow-Divide Valley) has potential well yields of 250 to 1000 gpm.

Depth to the water table varies from less than 50 feet in the northern portion of the valley (LaRocque) to approximately 80 feet in the Divide area (Montana Water Resources Board). Despite the lack of recharge data, the possibilities for an industrial supply of groundwater look promising, especially if a well field is developed (personal communication with Pete Norbeck, Bureau of Mines hydrologist, July 1977).

5.3.3.2 Groundwater quality

With total dissolved solids (TDS) levels of less than 500 ppm, groundwater quality in the Silver Bow-Divide Valley is considered to be excellent for domestic and irrigation use (Montana Water Resources Board, 1969, p. 28). Again, local areas of groundwater pollution may be present, but they would have to be located by intensive groundwater studies. Analyses of groundwater in the Big Hole Basin, Montana are shown in Table 5-3. Although these samples are not taken directly from the study area, they are thought to be representative of groundwater quality in the region.

5.3.4 Whitehall Area

5.3.4.1 Groundwater availability

The Whitehall-Jefferson River Valley area has the potential for yielding more than 500 gpm of groundwater to properly located and properly constructed wells (LaRocque, 1966, HA-217). About 110,000 acre-feet of groundwater is in storage and is available to wells in the 45,000 acre alluvial aquifer along the Jefferson River and its tributaries (Montana Water Resources Board, 1969, p. 38). Well logs from the Montana Bureau

Table 5-3.--ANALYSES OF WATER IN BIG HOLE BASIN, MONTANA

Analyses by Montana State Board of Health

Parts per million (a)

		1	2	3	4	5	6	7	8	9
Silica	SiO_2	17.0	47.0	59.5	13.5	15.5	48.5	22.0	25.0	40.0
Iron (ferrous)	Fe	2.6	trace	neg.	1.8	0.4	trace	trace	0.2	neg.
Aluminum & Iron	Al & Fe	11.4						5.0	10.0	neg.
Calcium	Ca	9.0	13.2	16.7	45.3	10.0	69.0	18.0	21.0	23.0
Magnesium	Mg	9.0	10.7	11.0	19.0	10.7	34.0	10.0	12.0	14.0
Sodium (and Potassium) (b)	Na (& K)	3.0	239.0	57.0	140.0	10.3	52.0	6.0	15.0	52.0
Carbonate acid radicle	CO_3	neg.	neg.	neg.	neg.	neg.	neg.	neg.	neg.	neg.
Bicarbonate acid radicle	HCO_3	62.0	638.0	153.0	534.0	95.0	418.0	120.0	144.0	144.0
Sulphate acid radicle	SO_4	4.0	55.6	71.0	41.7	5.5	34.5	8.0	4.0	41.0
Chlorine	Cl	7.0	9.0	7.0	9.0	5.0	30.0	5.0	8.0	45.0
Total hardness (c)		59.0	77.0	87.0	191.0	69.0	312.0	86.0	102.0	115.0
Total solids		102.0	696.0	262.0	713.0	96.0	484.0	134.0	197.0 173.0 (d)	287.0

No.	Name	Location	Depth	Temperature Nov. 2, 1933.	Remarks
1	Big Hole River	Wisdom	Surface	39° F.	Temperature slightly warmer than small creeks.
2	Hot Spring	Jackson	Surface	132° F.	100 or more g.p.m. Hydrogen sulphide present.
3	Strowbridge Big Spring	2 mi. N. W. Wisdom	Surface	44° F.	Volume fluctuates with seasons.
4	Wilson flowing well	Jackson	118		Volume of flow about 1 quart per minute.
5	Highland ranch well	3 mi. W. Briston School	160	42½°F.	First satisfactory water at 160 feet.
6	Miller ranch (U-U)	7 mi. S. Wisdom	14	48 °F.	Water considered very hard.
7	Ramsey residence	Wisdom	14	48 °F.	Moving water in bottom.
8	Holman residence	Wisdom	10	46 °F.	
9	Basin Mercantile Co.	Wisdom	12	46 °F.	

(a) Analyses are given in parts per million (p.p.m.). This is the common measure used by chemists in designating amounts of dissolved solids in water. An amount of 10,000 p.p.m. equals one per cent. To convert parts per million into grains per U. S. gallon divide by 17.1. Samples were collected November, 1933.

(b) Sodium and Potassium calculated. (c) Hardness calculated as calcium carbonate. (d) Loss on ignition.

Source: Perry, Memoir 12, 1934.

of Mines and Geology-Hydrology Division files indicate that fairly large groundwater yields are possible. For example, an irrigation well in the Whitehall area produces 700 gpm from a depth of 53 feet. Furthermore, 3 municipal wells in Whitehall (1-3/4 miles from the river) yield 300, 450, and 700 gpm, respectively (personal communication, Pete Norbeck, Bureau of Mines hydrologist, July 1977).

Depths to the water table are generally quite shallow; LaRocque indicates that the water level is within 50 feet of the surface, and the Montana Water Resources Board lists the depth to the water table at 4 to 56 feet. Well yields of 10 to 30 gpm are common in the alluvial aquifer; moreover, it has a potential of at least 250 gpm (Montana Water Resources Board, 1969, p. 39). Since no intensive groundwater studies have been done in the Whitehall-Jefferson River Valley, and no recharge information is available, it is difficult to make an accurate prediction of well yields. However, the available data indicates a potential for substantial groundwater yields in the Whitehall area.

5.3.4.2 Groundwater quality

Groundwater quality in the Whitehall-Jefferson River Valley area, similar to most of western Montana, is considered excellent for both domestic and irrigation use (Montana Water Resources Board, 1969, p. 38). Again, the lack of groundwater quality data in the area demonstrates the need for future study.

5.3.5 Butte-Anaconda Area Summary

Of the four districts in the Butte-Anaconda study area, the district with the best potential for an industrial groundwater supply is

the Deer Lodge Valley from Anaconda to Deer Lodge. Although the Whitehall and Divide areas seem to have potential, further studies are needed to define the availability of groundwater in these areas accurately. The Butte Valley can produce short term industrial supplies of groundwater, but a long-term sustained yield is questionable. Specific site studies will be needed if a definite location in the Butte-Anaconda area is selected.

5.4 Glasgow Air Force Base Area

5.4.1 Groundwater Availability

The best proven source of groundwater in the Glasgow area is the alluvium along the Milk and Missouri rivers; some wells in this alluvium are capable of yielding over 1,000 gpm to wells (Federal Energy Administration, 1975, p. 174). Wells located near the Milk or Missouri Rivers will benefit from induced infiltration of river water into the alluvial aquifer as the well is pumped. According to LaRocque (1966), more than 500 gpm of groundwater is available to properly located and constructed wells in the Milk and Missouri river alluvial valleys.

Beneath the Milk River flood plain, course sand and gravel aquifers in the buried valley fill of the preglacial Missouri are excellent water producers. These water-bearing units, which range from 45 to 200 feet in depth, vary in thickness from 5 to 20 (plus) feet. Reported well yields are commonly 10 to 20 gpm; however, the city of Glasgow uses three municipal wells, each rated at 1,000 gpm, from depths of 108, 112, and 121 feet (Montana Water Resources Board, 1968, p. 34).

In the Porcupine Creek alluvial valley, which lies northeast of Glasgow near the Air Force Base, 50 to 500 gpm of groundwater is generally available to properly located and constructed wells (LaRocque, 1966).

The water table is less than 50 feet below the land surface in the 20 to 50-foot deep alluvium. Other potential groundwater sources include alluvial aquifers along small streams, such as Cherry Creek, and alluvial deposits in bedrock valleys buried by glacial drift.

Glacial deposits, which are common in the Glasgow area, are composed mostly of till, a poor aquifer. However, gravel lenses, sand lenses, and outwash deposits are aquifers, and they may yield groundwater in certain areas.

Near Glasgow Air Force Base, the Flaxville Formation (a geologic horizon consisting of sand, gravel, and clay) is at the surface. Flaxville gravels have a high transmissivity and may produce large quantities of water in certain areas (Federal Energy Administration, 1975, p. 129). However, the formation has not been developed in the Glasgow area, and very little information on its potential is available.

Geologic layers beneath the Flaxville Formation include the Fort Union Formation and the Hell Creek-Fox Hills Sandstone. Some of the layers and lenses of sandstone and some of the coal seams are capable of yielding 5 to 30 gpm to wells (Federal Energy Administration, 1975, p. 133).

The Judith River Formation, a composite of sandstones, shales, and clays, lies underneath the Bear Paw Shale (an aquitard). The depth to the aquifers in the formation is usually in the range 100 to 500 feet. Normal yields from the Judith River are commonly in the range of 5 to 40 gpm; moreover, numerous wells report flowing yields (Montana Water Resources Board, 1968, p. 33). According to the Valley County Water Resources Survey (1968), every square mile of Valley County, underlain by the complete Judith River Formation, holds in storage about 10,000 acre-

feet of groundwater.

The groundwater potential of deeper aquifers has not been evaluated in the Glasgow area. Two deep aquifers show possibilities of producing large amounts of groundwater if properly developed. Sandstones in the Kootenai Formation at depths of 2500 to 4000 feet may contain a very large supply of artesian water; moreover, the Madison Limestone at depths of 6500 to 7500 feet may have the potential for producing an industrial supply of groundwater. However, the economic feasibility of drilling to depths of 6500 to 7500 feet is questionable; deep wells usually don't exceed depths of 2000 to 3000 feet (personal communication with Pete Norbeck, Bureau of Mines hydrologist, September 1977).

5.4.2 Groundwater Quality

The quality of the groundwater in the Glasgow area generally can be classified as poor for domestic consumption. Water in the alluvial aquifers contains total dissolved solids ranging from less than 1000 ppm to more than 3500 ppm (Montana Water Resources Board, 1968, p. 37). The chemical constituents with the highest concentrations are sodium, bicarbonate, and sulfate; other common ions include calcium and magnesium (see Table 5-4).

Outwash and Flaxville gravels are shallow sources of fair to good quality groundwater. The Fort Union, Hell Creek, and Fox Hills Formations also produce small amounts of good water. Production from wells tapping these formations usually is limited to stock or domestic use.

Water from the Judith River Formation often is mineralized so highly that it is unfit for drinking (Perry, Mem. 11, 1934). A table of groundwater analyses from the Judith River Formation is presented in Table 5-5. Water in the aquifer reportedly contains total dissolved

Table 5-4.--Water Quality Analysis of a Well in Alluvium of the Missouri River in the Glasgow CSA

NW4NW4NW4 sec. 31, T. 27 N., R. 43 E., Valley County, Montana[1]

Date of collection: October 9, 1947

Well depth: 30 feet

Silica[2]	16	Chloride	25
Iron	.97	Flouride	.5
Calcium	256	Nitrate	6.0
Magnesium	102	Boron	.25
Sodium	544	Total Dissolved Solids	1,370
Potassium	16	Hardness	653
Bicarbonate	441	Non carbonate Hardness	291
Carbonate	0	pH	7.6
Sulfate	672	Temperature °F	49

[1]Source of analysis is Hopkins and Tilstra (1966, p. 10).

[2]Concentrations are in parts per million.

Source: Federal Energy Administration, 1975.

solids in amounts of 2500 ppm to more than 4000 ppm. Chemical constituents vary somewhat from the shallow groundwater; calcium and magnesium are at lower concentrations, whereas chlorine is at much higher levels. Bicarbonate and sulfate usually are present in significant amounts.

Water quality data is unavailable for the deeper aquifers in the site area. The Kootenai Formation is known to produce good artesian water in central Montana, but its quality is unknown in the Glasgow area. Furthermore, although no data is available, the Madison is thought to be affected by an influx of saline water in the eastern part of Montana. This water can be considered as having a future potential for industrial use, but some pre-use treatment may be necessary (Montana Water Resources Board, 1968, p. 38).

5.4.3 Glasgow Air Force Base Area Summary

Based on a review of the available information, there are two potential sources of an industrial supply of groundwater in the Glasgow area: the stream channel and preglacial alluvium and the deep aquifers such as the Kootenai and the Madison. The alluvium is a proven source of small (less than 50 gpm) to large (exceeding 500 gpm) yields of groundwater; however, little is known about the deep aquifers. Future studies will be needed to determine their availability and applicability to an industrial process.

5.5 Great Falls Area

5.5.1 Sun River Valley and Vicinity (West of Great Falls)

5.5.1.1 Groundwater availability

Approximately 180,000 acre-feet of groundwater in storage is available to wells in the Sun River alluvial aquifer (Montana Water Resources Board, 1969, p. 50). Perennial recharge to the 122,000 acre aquifer amounts to 30,000 acre-feet. Well yields

Table 5-5.--Analyses of Groundwaters from the Judith River Formation in the Glasgow Candidate Site Area

	Near Glasgow			Near Nashua			
	21	22	23	24	25	26	27
SiO_2	26.5	32.0	38.0	20.0	5.5	neg.	26.4
R_2O_3*	13.5	9.6	11.0	6.0	neg.		6.4
Fe	neg.	7.0	0.3	0.6	neg.	neg.	0.6
Ca	6.4	5.0	18.9	10.3	14.6	14.0	11.1
Mg	14.6	4.3	9.8	5.5	12.3	6.0	5.4
Na K	833.0	868.0	1269.0	1156.0	1154.0	1149.0	1329.0
CO_3	neg.	33.0	63.0	neg.	neg.	neg.	neg.
HCO_3	1302.0	1333.0	412.0	890.0	1062.0	1089.0	781.0
C1	477.0	494.0	1114.0	1196.0	1177.0	1131.0	1555.0
SO_4	7.0	47.7	751.0	96.0	16.0	21.0	41.0
Total	2057.0	2090.0	3484.0	2848.0	2930.0	2879.0	3251.0
Hard.	77.0	30.5	88.5	49.0	88.0	60.0	51.0

* $R_2O_3 = Al_2O_3$ Fe_2O_3

Source: Perry, Memoir 11, 1934.

Table 5-5.--Locations (continued)

Well No.	Owner Name	Locality	Depth (ft.)	Temperature (°F)
21	Newton	Glasgow	721	47
22	Czyzeski	Glasgow	801	49
23	Lenz	Glasgow	-	-
24	Jensen	Whatley	432	53
25	Nichols (1933)	Nashua	-	60
26	Nichols (1933)	Nashua	-	-
27	Skudrud	Nashua	675	55

are commonly between 5 and 60 gpm, but a potential for 250 to 1000 gpm exists in the valley according to the Water Resources Board. LaRocque (1966) predicted groundwater yields to properly located and properly constructed wells of 50 to 500 gpm in the Sun River Valley. When the Madison (limestone) Formation is within economical drilling depth, it is one of the better possibilities for an industrial groundwater supply, up to 1000 gpm, (personal communication with Pete Norbeck, Bureau of Mines hydrologist, July 1977).

The water table in the alluvial aquifer lies at a depth of 5 to 6 feet below the land surface, whereas the Madison Formation is about 400 to 900 feet deep, depending on the surface elevation. Since the benchlands north and south of the Sun River are at a higher elevation than the river valley, the water bearing geologic layers are at greater depths. Deep aquifers, which have not been studied or tested, would have to be relied upon for a large supply of water because of the lack of proven shallow aquifers on the benchland. Therefore, the best proven source of groundwater is in the alluvial river valley, whereas the surrounding benchland will require more study before accurate predictions can be made.

5.5.1.2 Groundwater quality

Groundwater quality generally is considered to be excellent for domestic and irrigation use in the Sun River alluvial valley (Montana Water Resources Board, 1969, p. 50). Since no recent studies in the Sun River vicinity are available, local areas of polluted groundwater may be present. On the benchlands

north and south of the Sun River, groundwater quality varies widely (good to poor) depending on local conditions and the formation penetrated. Chemical analyses of water in the Cascade-Ulm area are presented in Table 5-6.

5.5.2 Missouri River-Stockett Area (South of Great Falls)

5.5.2.1 Groundwater availability

The Missouri River-Stockett area, which includes the Missouri River Valley and the Stockett-Sand Coulee district south of Great Falls, has a varying potential for groundwater yields. Along the Missouri River in the Cascade-Ulm area, the Montana Water Resources Board estimates that 135,000 acre-feet of groundwater in storage is available to wells in the 36,000 acre alluvial aquifer. The aquifer receives a perennial recharge of 20,000 acre-feet from the 15 inches of annual precipitation and the Missouri River and its tributaries (Montana Water Resources Board, 1969, p. 54). Reported well yields include flows up to 30 gpm and pumping yields up to 70 gpm from depths of 11 to 200 feet. LaRocque (1966) estimates that between 50 and 500 gpm of groundwater is available to properly located and constructed wells in the Missouri River Valley and in the Smith River-Stockett area south of Great Falls.

Groundwater in the Stockett-Smith River area is derived largely from the upper part of the Mission Canyon (Madison) Formation, lower Kootenai sandstones, and the Flood Member of the Blackleaf Formation (Goers, 1968). Alluvium along the Smith and Missouri rivers also supply water to wells. However, in spite of numerous sources, water is difficult to obtain locally.

Table 5-6.--Chemical Analyses of Well and Spring Water in the Cascade-Ulm Area (ppm).

Well number	126	57	5	125	21b*	48	59
Iron (Fe)	0.3	0.0	0.34	0.0	0.1	0.7	0.1
Calcium	553	53	39	4	53	60	100
Magnesium (Mg)	215	11	4	2	3	50	90
Sodium and potassium calc. (Na+K)	1,850	23	21	303	32	300	140
Carbonate radical (CO_3)	0	0	0	0	0	0	0
Bicarbonate radical (HCO_3)	480	198	162	543	204	503	485
Sulfate radical (SO_4)	4,790	47	25	200	35	555	462
Chloride (Cl)	630	13	0	16	6	10	23
Fluorine (F)	2.4	1	0.2	1.1	0.6	0.8	0.6
Nitrates (NO_3)	1.8	0	2.3	0	1.8	1	4.5
Total hardness (as Ca CO_3)	2.264	179	112	20	143	454	617
Total dissolved solids	8,546	254	175	772	236	1,195	1,078

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*Spring number.
(Analyses by Montana State Board of Health.)

Well or Spring No.	¼	Section	Township	Range	Material penetrated
126	NE	6	19 N.	2 E.	Alluvium
57	NE	35	18 N.	1 W.	Missouri R. Alluvium
5	SE	35	17 N.	2 W.	Missouri R. Alluvium
125	NE	5	19 N.	2 E.	Missouri R. Alluvium
21b	SW	27	18 N.	1 W.	Cascade Butte Aquifer
48	SW	24	18 N.	1 W.	Missouri R. Alluvium
59	NE	1	18 N.	1 E.	Flood Member-Blackleaf Formation

Source: Fox, 1966.

Large quantities of water are produced locally from the upper part of the Madison Group, but many expensive attempts to find water in the Madison have failed because of its varying permeability and porosity (Goers, 1968, p. 106). Water yields can be expected in areas underlain by underground channels, which are present only under a limited portion of the study area. One of the best and most utilized aquifers in the district is the Kootenai (sandstone) Formation. Moreover, yields exceeding 500 gpm have been obtained from the Kootenai in the Great Falls area at drilling depths of 250 to 2000 feet depending on location (Sollid, 1977). The Blackleaf Formation and the alluvium are also good sources of moderate to large yields of groundwater. According to Goers (1968), the best well drilling target in the Stockett-Smith River Area is the basal Kootenai conglomerate, which is present in the subsurface horizons across almost the entire area. In portions of the area where the basal Kootenai conglomerate is not present, the Swift Formation and the upper part of the Mission Canyon (Madison) Formation are the remaining potential targets. Along the valleys, alluvium still is considered to be a good source of fairly large groundwater yields.

5.5.2.2 Groundwater quality

Groundwater quality in the Missouri River alluvial aquifer is considered to be excellent for both domestic and irrigation use (Montana Water Resources Board, 1969, p. 54). Waters throughout the area are characterized by a lack of turbidity and the presence of calcium and sulfate because of the gypsum content in the Kootenai Formation (Fischer, 1909, p. 71). Most of the

groundwater in the Stockett-Smith River area is of good to excellent taste and of satisfactory chemical composition to be used for all domestic and stock purposes (Goers, 1968, p. 113). A large number of wells yield groundwater that is hard enough to require water softening treatment before domestic use. Chemical analyses of well water in the area are presented in Table 5-7.

5.5.3 Belt-Belt Creek Area (East of Great Falls)

5.5.3.1 Groundwater availability

In the Belt-Belt Creek area, which lies east-southeast of Great Falls, LaRocque (1966) predicts groundwater yields to properly located and properly constructed wells of 50 to 500 gpm. Throughout the area lying between Belt Creek and the Highwood Mountains, geologic conditions are favorable for the occurrence of artesian water (Fischer, 1909, p. 60). East of Belt Creek, the aquifers with water-bearing potential are the Kootenai sandstone and the alluvium in the valleys of Belt Creek and its tributaries. West of Belt Creek, outside of the alluvial valleys, water is difficult to obtain from the geologic horizons lying close to the surface. In the Belt area, the best source of good quality groundwater is the Madison Formation, which generally lies within 100 to 200 feet of the surface (personal communication with Pete Norbeck, Bureau of Mines hydrologist, August 1977). Average yields from the Madison are approximately 10 gpm, but conditions indicate that deeper and better-constructed wells could produce greater amounts.

5.5.3.2 Groundwater quality

The Madison Formation produces fair to good quality

Table 5-7.--Chemical Analyses of Well and Spring Water in the Stockett-Smith River Area (milligrams/liter).*

Well or Spring Number	141	142	122	X
Iron (Fe)	0	2.96	0	0.10
Calcium (Ca)	280	66	185	48
Magnesium (Mg)	119	66	38	71
Sodium and Potassium (Na-K)	105	68	15	75
Carbonate (CO_3)	0	0	0	0
Bicarbonate (HCO_3)	372	412	210	396
Sulphate (SO_4)	965	212	420	174
Chloride (Cl)	52	10	8	37
Fluoride (F)	1.4	2.0	0.8	1.1
Nitrates (NO_3)	34	8	25	20
Total Hardness (as $CaCO_3$)	1188	435	615	512
Total Dissolved Solids	1900	560	850	610

*Determined by the Montana State Board of Health.

Well or Spring No.	¼	Section	Township	Range	Formation Penetrated
141	NW	36	20 N.	4 E.	Alluvium
142	NW	36	20 N.	4 E.	Alluvium
122	NW	18	19 N.	5 E.	Madison Formation
X**	NW	2	19 N.	4 E.	Basal Kootenai Formation

** spring

water; two wells near Belt show 502 and 1000 ppm total dissolved solids (TDS), respectively (personal communication with Pete Norbeck, Bureau of Mines hydrologist, August 1977). Groundwater derived from shallower aquifers such as the Swift, the Kootenai, and the alluvium is usually of poorer quality because of the effect of acid-mine drainage in the area.

5.5.4 Floweree-Missouri River Area (North of Great Falls)

5.5.4.1 Groundwater availability

North of Great Falls, the possibilities for artesian water are very good, especially in the Kootenai and Madison Formations. Moreover, where alluvium is present in sufficient amounts along the Missouri River, moderate to large yields of groundwater can be expected. Wells penetrating the Sunburst sandstone in the Kootenai Formation near Floweree are reported to have flowed at 500 barrels per day--350 gpm (Perry, 1932, p. 5). Since the geologic formations dip to the north, even larger yields of flowing water can be expected north of Floweree towards Fort Benton. Because the surface formation in the area is largely Colorado Shale, wells must be drilled about 1000 to 2000 feet to penetrate the underlying Kootenai and Madison Formations. However, once these aquifers are tapped, the possibilities for a large supply of groundwater look promising.

5.5.4.2 Groundwater quality

Water flowing from the Floweree well was found to be unsatisfactory for domestic use; however, the water is believed to be derived from a formation beneath the Sunburst sandstone. The Sunburst horizon in the Kootenai Formation produces excellent quality groundwater near Great Falls and Belt. A number of chem-

ical analyses of well water from the Floweree-Fort Benton area are presented in Table 5-8.

5.5.5 Great Falls Area Summary

A number of potential sources of an industrial supply of groundwater exist in the Great Falls area. Aquifers showing the greatest potential include the Missouri River and Sun River alluvium, the Kootenai Formation, and the Madison Formation. Future studies are needed to further define the quantity and quality of groundwater available from these aquifers.

5.6 Livingston Area

5.6.1 Shields River Valley and Northern Upland Bench

5.6.1.1 Groundwater availability

North of Livingston, in the Shields River Valley alluvium, 6000 acre-feet of groundwater in storage is estimated to be available to wells (Montana Water Resources Board, 1969, p. 68). A perennial recharge of 1000 acre-feet is received by the 2000-acre alluvial aquifer. The water table is encountered at 2 to 20 feet in the alluvium. Large yields of groundwater sufficient for municipal, irrigation, or industrial use are limited to the alluvium of the Shields River Valley from the vicinity of the Shields River-Rock Creek junction to the Bangtail Creek junction (Groff, 1962, p. 1). For example, the Keys Ranch irrigation installation in the above alluvial deposit is capable of a 1,000 gpm yield from a 46-foot well (Groff, 1962, p. 6). Furthermore, topography indicates a potential for large groundwater yields in the Flathead Creek Valley and in the upper Shields River area, but further studies are needed for confirmation of the supply. According

Table 5-8.--Analyses of Water from Wells near Fort Benton

Silica (SiO_2)	19.0	23.0	23.4
Iron (Fe)	- -	.6	- -
Aluminum (Al)	- -	- -	10.2
Calcium (Ca)	201.0	102.0	40.9
Magnesium (Mg)	90.0	169.0	3.5
Sodium and Potassium (Na & K)	525.0	669.0	122.0
Carbonate Radical (CO_3)	- -	- -	- -
Bicarbonate Radical (HCO_3)	256.0	293.0	290.0
Sulphate Radical (SO_4)	1,669.0	1,936.0	125.0
Chloride Radical (Cl)	43.0	96.0	8.0
Total solids	2,715.0	3,300.0	487.0
Total hardness (as calcium carbonate)	872.0	948.0	117.0

A - Transcontinental Oil Company well, sec. 8, T. 23 N., R. 9 E.
B - Floweree well, sec. 19, T. 23 N., R. 6 E.
C - Wm. McKenzie well, 4 miles North of Coffee Creek, T.19N., R.13E.

Source: Perry, Miscellaneous Contributions No. 4, 1932.

to the Montana Water Resources Board, 1969, well yields in the alluvium along the Shields River and its tributaries range between 12 and 640 gpm, and a potential for up to 1000 gpm exists in T1N, R9E.

The upland benches, which lie north of the Yellowstone River and northeast of Livingston, are geologically part of the Livingston Formation. Generally, the Livingston Formation is capable of yielding small amounts of water for domestic and stock use except where it consists of impervious shale. Average yields of 8 to 10 gpm can be expected from wells at depths of 13 to 315 feet (Montana Water Resources Board, 1969, p. 68). However, large yields sufficient for industrial or irrigation use are not available except for the possibility of finding water in extensive fractured zones (Groff, 1962, p. 8). A large spring, Hunter Hot Springs, rises from a number of fissures in the Livingston Formation and flows about 1500 gpm, but it is an unusual case.

5.6.1.2 Groundwater quality

Water quality in the Shields River Valley alluvial aquifer is considered to be satisfactory for domestic use (Montana Water Resources Board, 1969, p. 68). According to Feth, et al. (1965), water in this area is of the sodium bicarbonate type and commonly contains between 1000 and 3000 ppm of dissolved solids. Springs analyzed in the area range between 156 and 736 ppm total dissolved solids (Groff, 1962, p. 11).

5.6.2 Yellowstone River Valley and Vicinity

5.6.2.1 Groundwater availability

In the Yellowstone River Valley alluvial aquifer, from Livingston downstream to the Park County line, approximately

30,000 acre-feet of groundwater in storage is available to wells (Montana Water Resources Board, 1969, p. 70). With a perennial recharge of only 5,000 acre-feet, the 10,000 acre alluvial aquifer could theoretically be dewatered by large groundwater withdrawals (10,000 acre-feet/year). Depths to water vary from 6 to 23 feet in the alluvium to 5 to 88 feet in the Livingston Formation.

The major water carrier again appears to be the alluvium; according to the Montana Water Resources Board the potential exists for yields up to 1000 gpm. Since the alluvium is thickest near the Yellowstone River, the largest yields can be expected near the stream. For example, four municipal wells which supply Livingston pump 100, 500, 800, and 900 gpm, respectively, from the Yellowstone River alluvium (Groff, 1962, p. 12-13). Furthermore, Layne-Minnesota Company, a groundwater development firm, predicted maximum yields of 220 to 1680 gpm from the alluvium during a groundwater study. Well yields from the Montana Water Resources Board records vary from 19 to 900 gpm in the alluvium to 5 to 15 gpm in the Livingston Formation. (Note: One municipal well in the Livingston Formation produces 800 gpm, but it is an isolated case).

South of the river and east of Livingston, the possibilities of producing a large supply of groundwater diminish. Although alluvium is present, it is usually too thin to produce much water. Other formations in the area, such as the Eagle Sandstone and the Kootenai Formation, are known to be good groundwater producers in other areas, but they are untested in this vicinity. Deep aquifers may be productive in this area; however,

further studies will be required to determine the feasibility of deep drilling.

5.6.2.2 Groundwater quality

Although some areas of local pollution may exist, the groundwater quality in the alluvial aquifer is considered to be satisfactory for domestic use (Montana Water Resources Board, 1969, p. 70).

During a water quality survey conducted by Layne-Minnesota Company (1954) for the city of Livingston, chemical analyses of well waters indicated a hardness ranging from 7.8 to 19.8 grains per gallon (1 grain/gal.=17.1 ppm). Wells investigated show a definite trend for an increase in water hardness as the well location moves toward the edge of the valley and away from the Yellowstone River channel, probably due to decreasing infiltration of river water into the aquifer. Water analyses from test holes drilled at permanent well sites in the Livingston area (Table 5-9) indicate that groundwater along the old channel of the Yellowstone generally has a hardness less than 12.5 grains per gallon (215 ppm). Based on the table, the groundwater in the area is a calcium bicarbonate type. The groundwater in the alluvial aquifer, as indicated by the available data, is generally of good quality (less than 500 ppm total dissolved solids).

5.6.3 Livingston Area Summary

In summary, the best chance for producing an industrial supply of groundwater is in the alluvium along the Yellowstone River. However, due to the moratorium on surface water in the Yellowstone basin, problems may arise with large withdrawals of groundwater (see Billings section). The Shields River alluvial valley has some potential, but the

Table 5-9.--Analyses of Groundwater in the Yellowstone Valley Alluvial Aquifer.*

Test** Well	Iron	Calcium	Magnesium	Sodium & Potassium	Carbonate radical
#1	0.08	58	17	22	0.0
#2	0.12	45	14	25	0.0
#2	0.1	47	12	19	0.0
#3	0.08	56	16	21	0.0
#4	0.0	48	20	16	0.0
#5	0.0	50	16	18	-
#6	0.0	51	15	21	-
#7	0.12	-	-	-	-
#9	0.12	-	-	-	-

Test Well	Bicarbonate radical	Sulphate radical	Chloride	Flourine	Total Hardness	Total Solids
#1	241	54	4	0.4	215.0	300.0
#2	189	34	15	0.5	170.0	250.0
#2	183	37	14	0.6	168.0	230.0
#3	201	65	10	0.7	207.0	275.0
#4	177	69	10	0.4	204.0	205.0
#5	217	35	13	0.5	190.0	275.0
#6	207	41	13	0.5	188.0	270.0
#7	262	-	14	-	216.0	370.0
#9	-	-	-	-	140.0	265.0

* Values in parts per million (ppm)

** Numbers refer to exact locations of wells in the Yellowstone Valley in the Livingston vicinity.

Source: Sollid, 1977.

chances for a large, sustained yield of groundwater seem questionable. Groundwater yields from deep aquifers in the Livingston area are unknown, and further study will be necessary to document a supply.

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6.0 LEGAL ASPECTS OF WATER AVAILABILITY IN MONTANA

6.1 History

According to the state constitution, all waters in Montana ". . . are the property of the state, for the use of its people. . ." (Department of Natural Resources and Conservation (DNRC) and Cooperative Extension Service, Circular 1192, 1976, p. 1). Furthermore, Montana waters are ". . . subject to appropriation for beneficial uses as provided by law."

Before July 1, 1973, the effective date of Montana's Water Use Act, water uses in Montana were guided by two legal principles. First, the water user is limited to withdrawing or diverting only that amount he could put to "beneficial use." The "Doctrine of Prior Appropriation" is the second legal principle; it states that a person's right to a certain quantity of water depends on when the use began (DNRC and Cooperative Extension Service, Circular 1192, 1976, p. 2). Because of the presence of several laws governing water rights and the lack of centralized records, confusion over the validity of water rights developed.

After passage of the Water Use Act, which established a centralized record system and provided for a permit system for any new or additional water development, the situation was changed. According to the Act, any new appropriations of water undertaken after July 1, 1973 must be accompanied either by a "Permit to Appropriate Water" or a "Certificate of Water Right", both granted by the Montana Department of Natural Resources and Conservation (DNRC) following certain procedures (DNRC and Cooperative Extension Service, Circular 1192, 1976, p. 2).

6.2 Securing a Permit

Anyone contemplating construction of a new surface water diversion or

impoundment or a water well with an anticipated beneficial use of more than 100 gallons per minute must apply for and receive a Permit to Appropriate Water before construction or drilling is initiated, or the water is diverted (DNRC and Cooperative Extension Service, Circular 1192, 1976, p.3).

The first step in securing a permit is to contact the DNRC and obtain Form No. 600--"Application for Beneficial Water Use Permit"; it also is available from county offices. This form is to be used to describe the intended use, location, amount of water, and purpose of the proposed project; furthermore, an application fee based on the quantity of water requested must accompany the formal application (DNRC and Cooperative Extension Service, Circular 1192, 1976, p.3).

After receiving the properly completed form and fee, the DNRC will make a preliminary assessment of the application to determine if there could be any adverse effects on existing water rights in the area. If no problems are expected, the formal public notification process may be waived, and the Permit to Appropriate Water is granted. The priority date, which can be quite important, is the date the DNRC receives the original permit application.

A permit must be granted by the DNRC if the following requirements are met (DNRC and Cooperative Extension Service, Circular 1192):

1. There are unappropriated waters in the source of supply;
2. The rights of prior appropriators will not be affected adversely;
3. The proposed means of diversion or construction are adequate;
4. The proposed use of water is beneficial;
5. The proposed use will not interfere unreasonably with other planned uses or developments for which a permit has been issued or for which water has been reserved; and

6. An applicant for an appropriation of 15 cubic feet per second or more proves by clear and convincing evidence that the rights of a prior appropriator will not be affected adversely.

6.2.1 Hearing Procedure

If the application indicates that potential adverse effects on other water uses may exist, formal notice of the application must be made public in local newspapers by the DNRC. Furthermore, any affected water user in the area, as determined from the DNRC's records, must be notified by mail. Local water users that may be affected then have the opportunity to file an objection (Form 611); moreover, if the objection is determined to be valid and an agreement cannot be reached among all parties, a hearing is conducted.

A hearing examiner evaluates all evidence presented at the hearing and issues a Proposal for Decision, which proposes to approve, modify, or deny the application for water use. Following the hearing, the Proposal for Decision is sent to the administrator of the Water Resources Division--DNRC; he is responsible for issuing a Final Order on the permit application. Persons who disagree with the hearing examiner's proposed decision may file an exception with the Administrator before the Final Order is issued. After the Final Order has been issued, dissatisfied individuals can appeal the decision to the Montana Board of Natural Resources and Conservation. A last form of appeal is in district court.

6.2.2 Large Appropriations

When water use applications request 15 cubic feet per second or more, the applicant must prove by "clear and convincing evidence" that the water rights of prior appropriators will not be affected adversely. Furthermore, large appropriations, such as groundwater appropriations

greater than 1000 gallons per minute, may fall under the Montana Environmental Policy Act, thereby requiring an Environmental Impact Statement (EIS). Additional fees may be required by the DNRC to cover costs if an EIS is necessary (DNRC and Cooperative Extension Service--Circular 1192, 1976).

6.3 After the Permit is Granted

After the "Permit to Appropriate Water" is granted, the holder must carry out the project and put the water to beneficial use. Following completion of the project, a second form entitled "Completion Report of Water Development" (Form No. 617) must be filed; it is for recording purposes only, and no fee is required.

6.4 Certificate of Water Right

According to the Water Use Act of 1973, existing water rights in the state must be determined and recorded through statewide adjudication, which involves the DNRC, the district courts, and the water users. The following steps are completed during the adjudication process (DNRC and Cooperative Extension Service--Circular 193, 1976):

- The DNRC chooses a drainage basin to adjudicate;
- Upon petition from the DNRC, the district court orders everyone in the drainage basin claiming existing water rights to declare them in writing to the DNRC within a period of one year;
- The DNRC conducts field investigations and studies to determine the validity of the claims;
- Based on these studies, the DNRC prepares recommendations and submits them to the district court;
- Based on the DNRC's recommendations, the court issues a Preliminary Decree, which specifies the ownership of each water right, together

with its priority date, purpose, period, place of use, source, place, and means of diversion, etc;

- Any water user who disagrees with the Preliminary Decree may challenge it before the court in the form of an appeal or an objection;
- The court issues a Final Decree, which reflects any changes that may result from appeals and objections; furthermore, it specifies in complete detail each water right in the adjudicated area and is final and conclusive; and
- The DNRC shall, on the basis of the final decree, issue a Certificate of Water Right which describes the water right and assures that it is recorded in the statewide records system to each person decreed an existing right.

After the adjudication process has been completed, those rights issued by the DNRC in the form of Permits to Appropriate Water will be added to the list of water rights according to their priority date. If the project has been completed and the water used according to the terms of the permit, a Certificate of Water Right will be issued to the permit holder (DNRC and Cooperative Extension Service--Circular 1192, 1976).

6.5 Changes in Water Use and Transfer of Water Rights

Any changes in water use, such as alterations in its purpose or in the location of use, diversion, or storage, must have prior approval from the DNRC. Changes are requested on Form 606, "Application for Change of Appropriation Water Right," and are allowed only after an authorization to change has been issued by the department. An appropriator of more than 15 cfs can not change the purpose of a water right from an agricultural to an industrial use.

Anyone who purchases land with an associated water right must file a "Notification of Transfer of Appropriation Water Right" (Form No. 608) with the DNRC. No prior approval or fees are required since the form is for record-keeping purposes only.

6.6 Surface Water Moratoriums

A major legal problem that may affect water availability is surface water moratoriums, such as the one currently in effect on the Yellowstone River. Under a moratorium, further appropriation of waters from the river or from the drainage basin is prohibited. Furthermore, withdrawal of groundwater near the stream channel also may be restricted due to its effect on stream water levels (see Billings and Livingston groundwater resources reports). Therefore, moratoriums on streams in the state surely will affect surface water availability, and they may restrict groundwater availability.

6.7 Summary

An application by MERDI to appropriate water to meet the requirements of the ETF will have to follow the permit system outlined above. Wells or developed springs with yields less than 100 gpm are subject to a much shorter process (see DNRC and Cooperative Extension Service--Circular 1192, p. 8).

Since the water requirements of the ETF may be sufficient to qualify it as a large appropriation, the burden of proving that the water rights of prior appropriators will not be affected adversely may be MERDI's responsibility. Furthermore, if the appropriation is determined to be a major action significantly affecting the quality of the human environment, an EIS will be necessary.

Until the requirements of the plant are known and the site is selected, the procedure for appropriating water only can be surmised.

LIST OF REFERENCES

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Department of Natural Resources and Conservation, Helena and Cooperative Extension Service, Montana State University, Bozeman, Montana, Water Development Projects & Wells - How to Apply for a Water Use Permit, Circular 1192, 1976.

Department of Natural Resources and Conservation, Helena and Cooperative Extension Service, Montana State University, Bozeman, Montana, Water Rights Adjudication - How the Process Works, Circular 1193, 1976.

Stone, Albert W., Montana and the Law of Groundwater, Montana Bureau of Mines and Geology, Information Circular 26, 1958.

7.0 CONCLUSION

Table 7-1 is a summary analysis of the existing condition of baseline parameters discussed in this report at each candidate site area. Since this evaluation does not cover all siting criteria and since the criteria presented may be weighted differently by each individual, the purpose of Table 7-1 is to identify problem areas, but not to rank one site against another. Until the other baseline data (e.g., social acceptability, socioeconomic parameters, noise level, land use, and archaeology) are quantified and impact analyses are conducted, the relative benefits or deficiencies of each site will be incomplete.

Table 7-1.--Summary Evaluation of Siting Critera

Parameters	Butte-Anaconda	Billings	Glasgow Air Force Base	Great Falls	Livingston-Bozeman
Groundwater availability	+	-	-	+	-
Air Quality Meteorology	-	-	0	+	+
Transmission Capability	+	+	-	+	+
Transportation Access	+	+	0	+	+

+ -- No problems are foreseen to meet this criteria

0 -- Potential problems exist but can be solved by engineering design

- Definite problems exist and must be resolved